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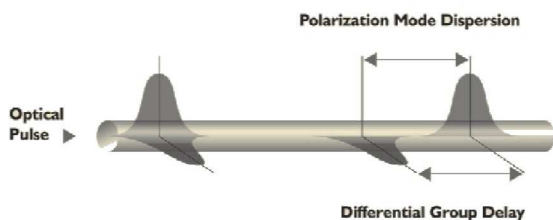
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**Agilent Technologies**



# User Guide





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# A1XXX/A2XXX/A3XXX User Guide

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Rev. 1.15

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# 1 General

## 1.1 Safety Instructions

- This instrument shall only be operated according to the instructions in this manual.
- Before this instrument (including external power supply) is connected to an electricity outlet make sure the outlet is provided with a protective earth contact. Also make sure that you use a three line AC power cord.
- The instrument and the external power supply do not contain operator serviceable parts. To prevent personal injuries or damage to the instrument do not open the devices. In case service is required please contact adaptif PHOTONICS under support@adaptif.de for instructions.
- The power supply has autoranging line voltage input. Make sure that the voltage provided in the electrical outlet is within the specified range.

## 1.2 Warranty–Terms and Conditions

adaptif PHOTONICS GmbH warrants the product to be free from defects in material and workmanship for a period of twelve months or the minimum legally required timeframe, whichever is larger. The warranty period starts with the date of the shipment. This warranty applies to the original purchaser and to any person to whom the product is given or sold during warranty.

Warranty service during the warranty period will be provided free of charge by adaptif PHOTONICS GmbH or one of its authorized service partners.

To receive Warranty service free of charge the requestor must provide the serial number and the date and location of purchase when requested to do so.

During the warranty period adaptif PHOTONICS may choose if a defective unit is repaired or replaced.

To receive warranty services the customer has to ship the unit to an address advised by adaptif PHOTONICS. This will be typically the headquarter of adaptif PHOTONICS in Germany or one of its authorized service partners. Costs for shipment of the defective unit to adaptif PHOTONICS have to be born by the customer. In case the repair is covered by warranty adaptif PHOTONICS carries the costs for the return shipment.

### 1.2.1 Limitation of Liability

adaptif PHOTONICS GmbH is not liable for lost profits and incidental or consequential damages.

### 1.2.2 Warranty Extension

The customer may extend this warranty when purchasing the instrument by buying a warranty extension covering a total warranty timeframe of twenty-four or thirty-six months.

### 1.2.3 Technical Support

adaptif PHOTONICS GmbH provides technical support to the customer during the warranty period free of charge. The support may be provided through Email, telephone or other means.

### 1.2.4 Validity

adaptif PHOTONICS GmbH reserves the right to change the terms and conditions of the warranty at any time. Binding are the terms and conditions which have been in place at the time of the purchase of the instrument.

## 2 Getting Started

### 2.1 About this manual

This manual covers all adaptif PHOTONICS instruments. There may be applications or functions described within, which cannot be performed with a specific instrument. The sections or chapters of this manual contain product numbers like A2000, A3XXX or AXXXX-B3/R3. These product numbers indicate the instruments that the specific section applies to.

Many functions and applications are controlled using an external Personal Computer (PC), so a large portion of this manual is about software and refers to screenshots.

Instruments from the AXXXX-B3/R3 series comprise an integrated PC, where the adaptif PHOTONICS software will run in a compact display mode, optimized for touch-screen control, which will be called Integrated PC Mode throughout this manual. Therefore you will often find pairs of screenshots, one of them referring to the External PC Mode, the other one referring to the Integrated PC Mode. In most cases, the functions are exactly the same in both modes, but for better accessibility they may be rearranged.

### 2.2 Connectors and Controls

The following sections provide an overview of the optical and electrical connectors, as well as the control elements of the adaptif PHOTONICS instruments. Throughout this document you will find references to the connectors and controls shown in the respective figures.

#### 2.2.1 A1000 Front Panel



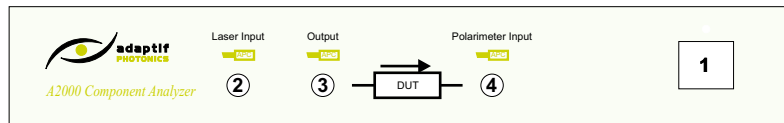
1. Power switch
2. Optical connector - Polarimeter Input (SMF)

#### 2.2.2 A1200 Front Panel



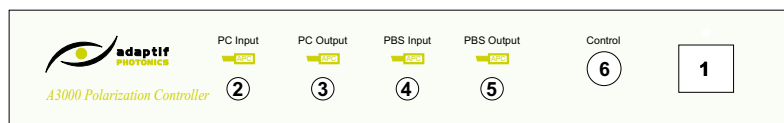
1. Power switch
2. Optical connector - Laser Output (SMF)
3. Optical connector - Polarimeter Input (SMF)

### 2.2.3 A2000 Front Panel



1. Power switch
2. Optical connector - Laser Input (SMF)
3. Optical connector - LiNbO3 polarization controller (PC) Input (SMF)
4. Optical connector - Polarimeter Input (SMF)

### 2.2.4 A3000 Front Panel



1. Power switch
2. Optical connector - LiNbO3 polarization controller (PC) Input (SMF)
3. Optical connector - LiNbO3 polarization controller (PC) Output (SMF)
4. Optical connector - Polarization beam splitter (PBS) Input (SMF)
5. Optical connector - Polarization beam splitter (PBS) Output (PMF)
6. Control button

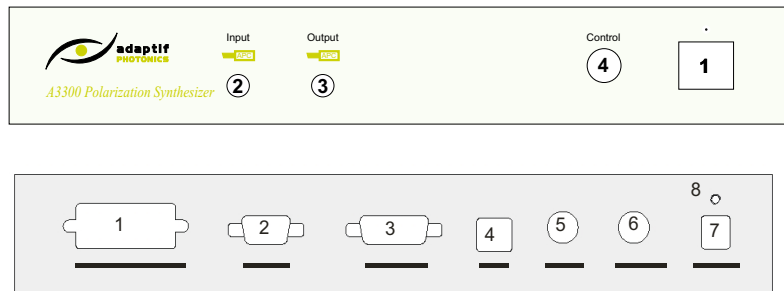
### 2.2.5 A3200 Front Panel



1. Power switch
2. Optical connector - Synchronous Scrambler Input (SMF)
3. Optical connector - Synchronous Scrambler Output (SMF)

### 2.2.6 A3300 Front Panel

1. Power switch
2. Optical connector - Polarization Synthesizer Input (SMF)
3. Optical connector - Polarization Synthesizer Output (SMF)
4. Control button



## 2.2.7 AXXXX Back Panel

1. IEEE 488.2 connector (GPIB)
2. RS 232 connector (Use standard 9-pin extension cable for connection to a COM-port, not a NULL-modem cable)
3. Expansion connector. Provides Trigger Input #2 (see block diagram), as well as analogue outputs and is used to connect accessories (e.g. the A1210 Thermal Cycling Unit) to the device.
4. USB connector (compliant to USB1.1)
5. Trigger Input #1, TTL-Compatible (see appendix)
6. Trigger Output, TTL-Compatible (see appendix)
7. Power Supply Input
8. Thread for optional ground connection

## 2.2.8 A1000-B3/R3 Front Panel (19" Version with integrated PC)



1. Power switch
2. Touch screen
3. Modification knob
4. Escape (ESC) button
5. Accept (OK) button
6. Cursor left button
7. Cursor right button
8. USB connector (compliant to USB2.0)
9. Optical connector - Polarimeter Input (SMF)

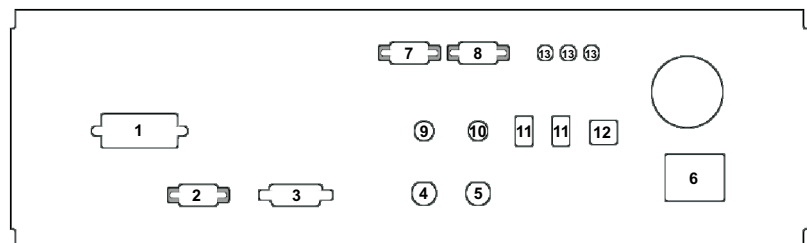




### 2.2.9 A2000-B3 Front Panel (19" Version with integrated PC)

1. Power switch
2. Touch screen
3. Modification knob
4. Escape (ESC) button
5. Accept (OK) button
6. Cursor left button
7. Cursor right button
8. USB connector (compliant to USB2.0)
9. Optical connector - Laser Input (SMF)
10. Optical connector - Polarization Controller Output (SMF)
11. Optical connector - Polarimeter Input (SMF)

### 2.2.10 AXXXX-B3/R3 Back Panel (19" Version with integrated PC)



1. IEEE 488.2 connector (GPIB)
2. adaptif PHOTONICS service connector
3. Expansion connector. Provides Trigger Input #2 (see block diagram), as well as analogue outputs and is used to connect accessories (e.g. the A1210 Thermal Cycling Unit) to the device.
4. Trigger Input #1, TTL-Compatible (see appendix)
5. Trigger Output, TTL-Compatible (see appendix)
6. Power Supply Input, center pin positive
7. VGA output
8. RS 232 connector (Use standard 9-pin extension cable for connection to RS 232-controlled device)
9. PS/2 keyboard connector

10. PS/2 mouse connector
11. USB connector (compliant to USB2.0)
12. LAN connector (10/100MBit/s)
13. Audio connectors (not supported)

## 2.3 Software Installation/Software Updates

*Install the software before  
you plug-in the hardware*

The A1XXX/A2XXX/A3XXX come with the polarizationNAVIGATOR™ software to provide optimum performance. All drivers and supplements are included in the installation package.

The polarizationNAVIGATOR™ software is pre-installed on AXXXX-B3/-R3 instruments. To install the software on other Adaptif instruments use the CD supplied with the instrument:

- Insert the CD into your CD drive. If the installer does not automatically start, open the Windows Explorer and start **setup.exe** in the root directory of the CD.

Download the latest software updates (if necessary):

- Download the latest version of the polarizationNAVIGATOR™ from [www.adaptifphotonics.com](http://www.adaptifphotonics.com).

User: **customer**

Password: **sphere314**

- Double-click the self-extracting .exe-file and follow the instructions. NOTE: You have to restart the computer if Windows tells you so. Otherwise the software may not work correctly.

## 2.4 Connect the Instrument

*Install the software before  
you plug-in the hardware*

If you have installed the software, you can connect the instrument to your computer.

Instruments of the AXXXX-B3/-R3 family don't require an external computer and therefore this section does not apply. To connect other Adaptif instruments you have two options:

- Use the USB interface (preferred)
- Use the GPIB interface

### 2.4.1 Connecting the Instrument to the USB Interface

Connect the instrument to the computer and turn it on. The front panel LED should turn to green after a few seconds.

*The driver is not signed -  
Please install anyway.*

On first installation, WINDOWS will come up with a message stating that the driver is not signed. Please install the driver anyway.

After the driver installation is complete, start the polarizationNAVIGATOR™ software.

## 2.4.2 Connecting the Instrument to the GPIB Interface

*National Instruments VISA has to be installed.* Use a standard GPIB cable to connect the A1XXX/A2XXX/A3XXX to the PC. On the PC, National Instruments VISA has to be installed to provide the GPIB functionality. Usually VISA comes with your GPIB board, but may not be automatically installed on your system. Check your GPIB board's driver CD or contact National Instruments for more information about VISA.

The default GPIB address is 30. Please refer to *Changing the GPIB Address* (section 2.8) on how to change the GPIB address. You can check the correct installation if you turn on the instrument and wait for the LED switch to green. Then start the National Instruments Automation Explorer on your PC, make a right-click on the GPIB interface the A1XXX/A2XXX/A3XXX is connected to and scan for new instruments. The instrument should be detected on address 30.

## 2.5 Connecting Tunable Laser Sources

*Connect your TLS to the GPIB port of the Axxx.* The software supports tunable laser sources (TLS) of the major vendors at the market. Refer to the FAQ section in the online help on which models are supported.

The polarizationNAVIGATOR™ software can communicate with these laser sources either via the instrument's GPIB port (in that case the instrument's GPIB port is used as GPIB-Master, see *Using the Axxx as GPIB Interface* (section 2.7) for details) or via a GPIB board installed in your PC.

Connect the TLS to the appropriate interface, turn it on and run the *Configuration Wizard*. The TLS should then be listed under "Misc. Instruments".

*Don't forget the BNC trigger cable!* Some laser sources need a trigger cable connected to the Axxx. Refer to *Measurement Setup Using the A2000* (section 6.2.9) or *Measurement Setup Using the A1000/A3XXX* (section 6.2.10) for details on how to connect the trigger cable(s).

## 2.6 Run the Configuration Wizard

Now that the software is installed, the instrument is connected and turned on, you can start the polarizationNAVIGATOR™ software and run the *Configuration Wizard*.

On first startup the *Configuration Wizard* will come up automatically. If you want to rerun the *Configuration Wizard*, you can click on the button named *Wizard* or click on *Tools*→*Configuration Wizard* in the menu.

Please follow the instructions shown in the dialog box.

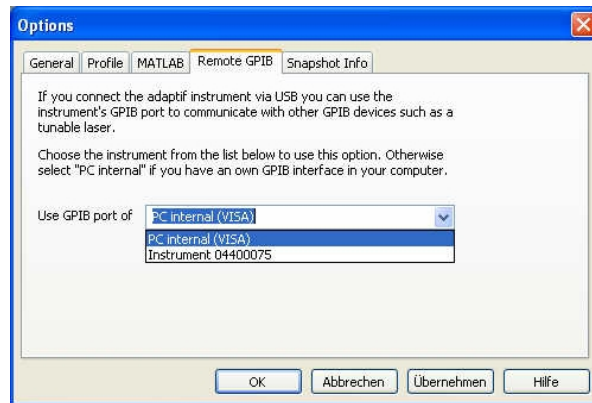
Instruments of the AXXXX-B3/-R3 family only require execution of the *Configuration Wizard* if external devices are connected via GPIB or RS232 (e.g. tunable laser sources).

## 2.7 Using the Axxx as GPIB Interface (Remote GPIB)

The Axxx instrument can be used as GPIB-Master to control third-party instruments. This mode is referred to as *Remote GPIB*. In that case, the Axxx has to be connected to the PC via the USB port.

We recommend to connect your GPIB instrument to the GPIB port of the Axxx instrument and run the *Configuration Wizard*.

Go to *Tools*→*Options*→*Remote GPIB* to change the settings manually. If you have one or more Axxx instrument connected to your PC via USB, you can select the instrument you want to use as remote GPIB interface by its accordant serial number listed in the drop down menu. Otherwise or for using the internal GPIB interface of the computer please choose *PC internal (VISA)*.



NOTE: The polarizationNAVIGATOR™ software fully supports the remote GPIB port. However, it does not behave like a standard GPIB interface for other software such as LabView™.

## 2.8 Changing the GPIB Address

The default GPIB address of the A1XXX/A2XXX/A3XXX is set to 30. To change the GPIB address, proceed as follows:

- Connect only the A1XXX/A2XXX/A3XXX to the GPIB interface and turn it on.
- Start the polarizationNAVIGATOR™.
- If the instrument is not yet listed in the browser window click on *Tools*→*Scan for Instruments* and scan for new instruments. The instrument should be detected with its current GPIB address (factory setting: 30). A new item appears in the browser representing the instrument (the A1XXX is listed under *Polarimeters*, the A3XXX is listed under *Polarization Controllers*, the A2XXX is listed in both).
- Show the properties dialog of the instrument by right-clicking on its item and choosing *Properties*
- Click on *Change at Device* on the Interface-Tab.
- Enter new GPIB address (10..30) and click on OK.
- Turn the instrument off and back on to apply the changed address.
- In the properties dialog click on OK.
- Run the *Configuration Wizard* again.

## 2.9 System Requirements

Light source with single mode fiber output (connector: FC/APC or FC/PC, depending on instrument input)

Personal Computer (included with instruments of the AXXXX-B3/-R3 family):

- Intel Pentium III, 700 MHz or higher
- Windows 2000 or Windows XP

If connected via USB:

- Available USB (1.1 or higher)

If connected via GPIB:

- National Instruments VISA-compliant GPIB interface
- VISA driver (usually shipped with the interface)

Optional:

- National Instruments LabView™ 6.1 or higher
- MATLAB 6.1 or higher

## 2.10 Delivered Items

The following items are delivered with the A1XXX/A2XXX/A3XXX (Please contact us in case of missing parts):

- The A1XXX/A2XXX/A3XXX instrument
- Power supply/AC adapter
- Power cable
- USB cable
- CD: polarizationNAVIGATOR™ (includes LabView™ driver)
- User Manual

The following items are delivered with the AXXXX-B3/R3 (Please contact us in case of missing parts):

- The AXXXX-B3/R3 instrument
- Power cable
- User Manual

## 3 Basic Operation AXXXX-B3/R3 (19" Version with integrated PC)

### 3.1 Activating the AXXXX-B3/R3

Use the supplied power cable to connect the instrument to a power socket. Depending upon the previous state of the instrument it may power up immediately. Otherwise push the button at the right of the instruments front plate. The computer will boot Windows XP Professional and will auto-login with administrative privileges. In case you need to login manually, use

User: **Administrator**

Password: **sphere314**

The polarizationNAVIGATOR™ software will startup automatically after booting. After manual login it can be started using the icon on the desktop or from the start menu.

Throughout the system the touch screen acts as a mouse. For right-click operations there is an always-on-top icon, which will turn the next touch to a right-click touch. If this icon is not on the screen it can be reactivated from the system tray by clicking on the pm-icon and setting a mark next to "Right Button". You will have to quit the polarizationNAVIGATOR™ in order to access the system tray.

In addition the knob on the front plate can be used for cycling through lists of buttons and for changing numerical values. Pressing the wheel is similar to pressing the "OK" button and will push a button or accept a numerical value. The "ESC" key will toggle between menu access (File, Edit, View, etc.) and button access and it will abort changing numerical values. The "Left Arrow" and "Right Arrow" buttons will switch between different graphs (PMD, PDL, DOP, Stokes-Parameters, etc.) and will change the cursor position in dialog boxes. For most dialogs, special on-screen-keyboard-dialogs will appear. In case you need to enter additional characters, Windows provides an always-on-top on-screen keyboard, which can be activated by pressing the wheel twice in quick succession. For using this feature, the polarizationNAVIGATOR™ has to be running. A link to the on-screen keyboard is placed on the desktop, which can be used otherwise. The on-screen keyboard is not available for entering the password at the Windows login screen. When powering up the instrument, it will log on automatically. To login again after logging out, you need to either connect a keyboard to the instrument to enter the password or restart the instrument to log in automatically again.

Furthermore, USB and PS/2 keyboards and mice can be connected to the AXXXX-B3/R3.

Using any of these controls choose an application and use the control buttons for setting the specific parameters and controlling the application. Usually the horizontal row of buttons switches between several subsets of functions or parameters, which are then listed as a column of buttons to the right. There may be more items in a horizontal or vertical set than buttons. In this case a "More" button will be among the set of buttons. Usually you will find an "Exit" button, which will stop the active application. The actual parameters and functions are similar to those described in the specific chapters of the manual (A1000-B3/R3: see section *Application: Polarimeter* (section 6.1) and A2000-B3/R3: see section *Application: PDL/PMD* (section 6.2))

## 3.2 Network Access

Measurements are stored in *D:\My Documents\My PolarizationNavigator Files* and *D:\My Documents\My PolarizationNavigator History*.

You can access these files from a remote computer by using the Windows Explorer, the Internet Explorer or an FTP client. When connected through a local area network, you can use the instruments name, which consists of its type and its serial number to access the folders, e.g.:

```
ftp://a2000-04400001/Measurements/  
ftp://a2000-04400001/History/
```

When connected through the internet, you have to use the IP address of the instrument to access the folders, e.g.

```
ftp://192.168.0.1/Measurements/  
ftp://192.168.0.1/History/
```

You can find the IP address of the instrument by using the corresponding polarizationNAVIGATOR™ function from the *Tools* menu or by running the *ipconfig* command from the command prompt if you have a keyboard connected.

For accessing these folders, you have to login with the following information

User: **Administrator**  
Password: **sphere314**

## 3.3 Remote Control

The AXXXX-B3/R3 can be controlled remotely. Doing this you can either use the *Remote Desktop Connection* tool of Windows XP or a web-interface based on an Active-X control. The AXXXX-B3/R3 is configured to listen for remote access requests. Routers and Firewalls have to be configured to allow TCP port 3389 for Remote Desktop access and TCP port 80 for the web based interface.

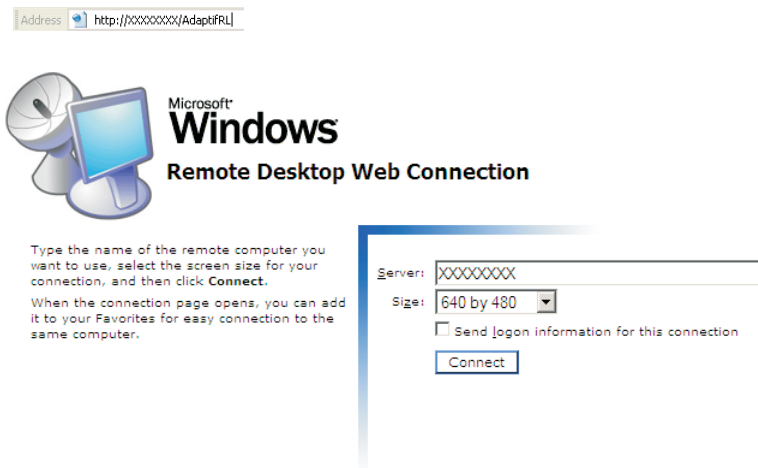
### 3.3.1 Remote Desktop Connection Tool

On the computer from which you want to remote-control the instrument open the start menu and run *Programs→Accessories→Communications→Remote Desktop Connections*. In case the instrument is in the same local network it can be addressed by the instrument's name, which contains the instrument type and the serial number of the instrument (e.g. A2000-04400001). If the instrument is not in the same local network, you have to enter the IP address of the instrument instead of its name. You then are prompted with the remote login screen and have to login as administrator.

User: **Administrator**  
Password: **sphere314**

### 3.3.2 Web-Interface

You can use the internet explorer to connect to the IP address of the instrument at port 80 and choosing the subfolder called *AdaptifRL* (e.g. *http://192.168.1.1:80/AdaptifRL*). For using the remote control access you need a certain Active-X plugin provided by Microsoft, which will be installed automatically if not installed already.



You will then be prompted to enter the server name, i.e. its IP address, if you connected using the IP address or the instruments name, containing the instrument type and the serial number of the instrument (e.g. A2000-04400001) if you connected using the instruments name. In addition you can choose the screen resolution (640x480 is the native resolution of the instrument). After pressing *Connect* you have to press space or a mouse button to gain control of the remote instrument. You then are prompted with the remote login screen and have to login as administrator.

User: **Administrator**

Password: **sphere314**

You can create a link like this

<http://x.x.x.x/AdaptifRL/?Server=x.x.x.x&AutoConnect=1&FS=1>

to skip the configuration screen, where x.x.x.x is the IP address or the name of the remote instrument.

### 3.3.3 Remote File Access

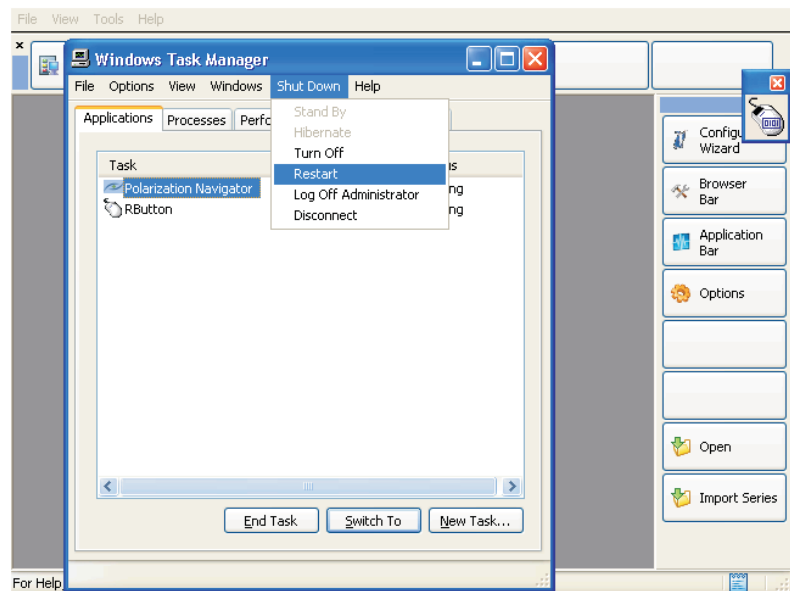
### 3.3.4 Rebooting the Remote System

You can force a reboot of the remote instrument by pressing *CTRL-ALT-END* in the remote session and then select *Shut Down→Restart*.

## 3.4 Recovery Console

The AXXXX-B3/R3 instruments provide an emergency recovery tool. If the system is corrupted, you can connect a keyboard to the instrument and press *ESC* during the boot process. You will be prompted to do so while still in text mode. You can then choose the *adaptif PHOTONICS Recovery Console* from the boot menu and will be guided through the recovery process. This recovery tool will only recover the C:\ drive, i.e. the system drive. It will reset the polarizationNAVIGATOR™ to the version the instrument has been delivered with. Therefore the polarizationNAVIGATOR™ may prompt you for updating the instruments firmware, if you have performed any updates. You may have to re-apply the corresponding update after the recovery. The D:\ drive, which contains your measurements will not be modified during the recovery.





## 4 Basic Operation A1XXX/A2XXX

### 4.1 Activating the A1XXX/A2XXX

When the polarizationNAVIGATOR™ is started it will not automatically perform any measurements. The browser window will show an icon for each adaptif PHOTONICS instrument or supported external instrument (e.g. tunable laser sources) that has been either added by using the Configuration Wizard or added and configured manually. A green arrow indicates that the instrument is activated, i.e. communication has been established. Before using the instrument with the polarizationNAVIGATOR™ it has to be activated.

There are two ways to activate an instrument. It can be activated directly or an application can be opened, which will then activate the required devices automatically.

Double-click on an instrument to activate it (or click on *activate* in its context menu). The polarizationNAVIGATOR™ can activate instruments automatically at startup. To use this feature, check *Activate On Startup* in the instruments context menu. After activation, a green arrow should appear on the icon of the instrument and the polarimeter of the A1XXX/A2XXX continuously measures the polarization state (SOP) of the received light. Sub-items appear below the A1XXX/A2XXX entry representing different views of the acquired data.

Double-click on an application to open it. The PMD/PDL/Loss-Application, for instance, will activate a supported tunable laser source and adaptif PHOTONICS instruments for polarization analysis and polarization control (e.g. an A2000 or a combination of an A1000 and an A3200). If any of the instruments required for the specific application is missing, there will be an error message and the application won't open.

When using an AXXXX-B3/R3 instrument you just choose the Polarimeter-Application from the top button row.

After activating the device as described above, refer to section *Application: Polarimeter* (section 6.1) for a detailed description of the polarimeter functions of the instruments (A1000 / A2000).

Refer to section *Application: PDL/PMD* (section 6.2) for a detailed description of the functions (A2000 / A1000 + A3xxx) for measuring PMD and PDL.

Refer to section *Application: PER/PMF Crosstalk* (section 6.4) for a detailed description of the functions (A1000 / A1200 / A2000) for measuring the polarization extinction ratio in a polarization maintaining fiber and for measuring the splicing angle between two polarization maintaining fibers.

Note that a proper light source has to be connected to the instrument for performing measurements.

## 5 Basic Operation A3XXX

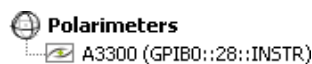
### 5.1 Activating the A3XXX

When the polarizationNAVIGATOR™ is started it will not automatically perform any measurements. The browser window will show an icon for each adaptif PHOTONICS instrument or supported external instrument (e.g. tunable laser sources) that has been either added by using the Configuration Wizard or added and configured manually. A green arrow indicates that the instrument is activated, i.e. communication has been established. Before using the instrument with the polarizationNAVIGATOR™ it has to be activated.

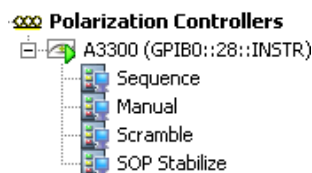
There are two ways to activate an instrument. It can be activated directly or an application can be opened, which will then activate the required devices automatically.

Double-click on the A3XXX to activate it (or click on *activate* in its context menu). The polarizationNAVIGATOR™ can activate instruments automatically at startup. To use this feature, check *Activate On Startup* in the instruments context menu. After activation, a green arrow should appear on the icon of the instrument. Three Sub-items appear below the A3XXX entry corresponding to three control windows (four in case of the A3000/A3300).

inactive polarimeter:



active polarization controller:



The *Sequence* window allows you to load a sequence of SOPs, which will be generated by the A3XXX. In addition basic operation parameters of the *Sequence* mode can be set in this window, such as repetition rate, timebase, polarimeter synchronization etc.

The *Manual* window allows you to control the polarization controller in the manual mode by means of sliders, each of which corresponding to one of the *modulator stages* (section 5.2) .

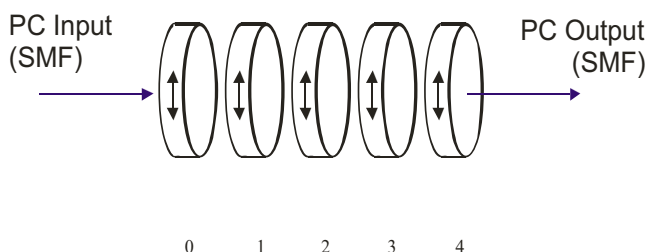
The *Scramble* window is similar to the *Sequence* window, except that a list of random SOPs is generated, which will be generated by the A3XXX. In addition, basic operation parameters of the *Scramble* mode can be set in this window, such as repetition rate, timebase, polarimeter synchronization etc. Activating the *Scramble* mode will replace any previous sequence.

The *SOP-Stabilize / Stabilize* window (A3300/A3000) is used to configure the stabilizer modes of the respective instruments.

## 5.2 A3XXX Polarization Controller Operation

### 5.2.1 Introduction

The operation of the LiNbO<sub>3</sub> polarization controller (PC) integrated with the A3xxx family is comparable to a cascade of five endlessly rotatable waveplates:



The state of the PC is given by the position of the waveplates which is expressed in terms of five angles  $\varphi_0 \dots \varphi_4$  measured in rad (ranging from  $0 \dots \pi$ ). Due to the internal structure of the PC the waveplates are endlessly rotatable, i.e. there will be no polarization state transition when turning the position from  $2\pi$  back to 0.

Note that the retardation may slightly differ from the nominal values depending on the operating wavelength and also temperature. Furthermore there may be a systematic deviation due to the electro-optic properties of the LiNbO<sub>3</sub> polarization controller. Usually these deviations are not an issue since in most applications the polarization is adjusted in an adaptive way (like for manual fiber-loop polarization controllers).

The angles can either be set statically or dynamically. Dynamic change is implemented by means of a look-up-table stored in the memory of the instrument. This look-up-table can be processed once or repeatedly at different clock rates. Triggering or synchronizing with an external clock is also possible.

### 5.2.2 Manual Operation

In manual operation mode the polarization can be adjusted by manually setting the five angles  $\varphi_0 \dots \varphi_4$ . The operation is comparable to manual fiber-loop polarization controllers. In the polarizationNAVIGATOR™ software settings can be saved and restored.

### 5.2.3 Scrambling Operation

In scrambling mode a polarization fluctuation is created by rotating the waveplates at different speeds. The step size can be chosen as well as the clock rate.

### 5.2.4 Sequence Operation

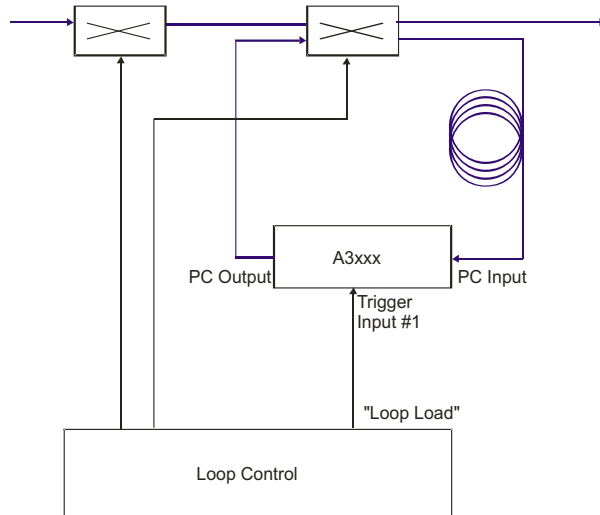
In sequence mode a look-up-table given in an ASCII text file can be uploaded to the instrument.

### 5.2.5 Loop Synchronous Operation in Optical Loop Test Beds

In scramble mode and sequence mode the instrument can be synchronized to external events to support synchronous operation to optical loop test beds. Two configurations are recommended:

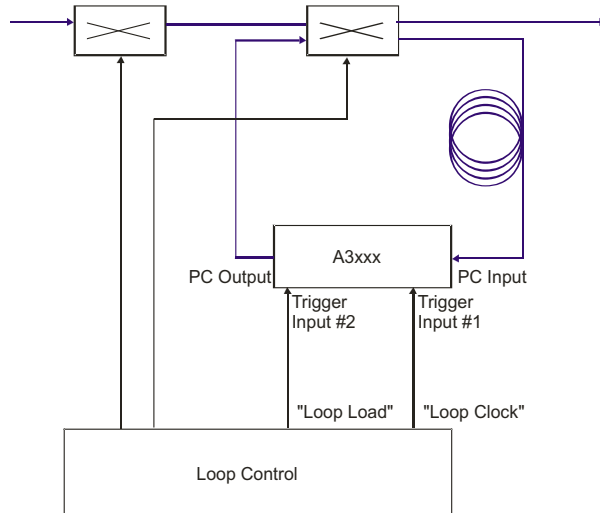
### *No Loop Clock Internal Timebase*

In this configuration the Axxx is synchronized to the beginning of the loop sequence when the fiber loop is loaded with the optical burst data. It then processes the look-up-table (either generated for scrambling or loaded from a file) using an internal clock timer. The loop cycle time depends on the length of the fiber loop. You have to find the clock rate and the phase of the PC manually to match the switching times with the loop cycles.



### *Synchronized to Loop Clock External Timebase*

In this configuration the Axxx is synchronized to the loop clock. Switching occurs on the rising edge of the signal applied to the trigger input #1. The look-up-table pointer is reset to the beginning when trigger input #2 is made logical high for at least 100  $\mu s$ .

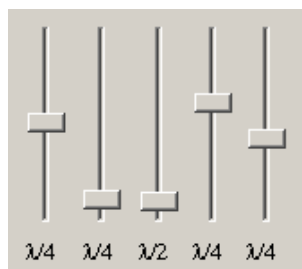


## 5.3 A3XXX Polarization Controller Software Settings

When the A3xxx is activated by clicking on the polarization controller symbol, three (four in case of the A3300) sub-items named *Sequence*, *Manual* and *Scramble* appear below the symbol. These sub-items represent dialog bars which can be shown by double clicking on the sub-items.

### 5.3.1 Direct Control of Waveplate Positions

By double-clicking the *Manual* sub-item, a dialog is opened, containing five sliders. Move the sliders to adjust the position of each waveplate.



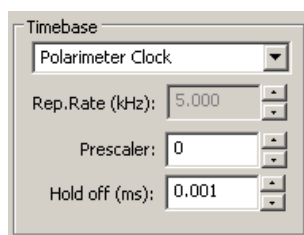
You can store a complete setup by pressing the CTRL key while clicking on a memory button of the control-bar. Simply click on the desired memory button to recall the setup. Note: The software remembers the setups even when it is restarted.



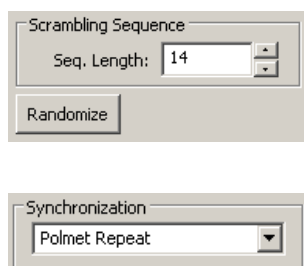
### 5.3.2 Random Polarization Scrambling

The scrambler operation is activated by double-clicking the sub-item *Scramble* of the A3XXX instrument. This will also show a dialog for setting the parameters of the scrambler.

For simple asynchronous operation turn *Timebase* to *Timer* and choose a repetition rate. The repetition rate is the clock used for processing the look-up-table. If the field *Prescaler* is greater than 0, the clock is divided by  $Prescaler+1$ .



Scrambling is implemented by generating a special look-up-table. The table length can be chosen by the field *Seq. Length*. Larger values make the polarization controller steps smaller and increase the size of the look-up-table. By pressing the *Randomize* button, the current pattern is replaced by a new set of random SOPs.



If *Synchronization* is set to *Auto Repeat*, the scrambling sequence is processed repeatedly without any external synchronization.

If *Synchronization* is set to *Auto Oneshot*, the scrambling sequence is processed just once. The polarization controller remains on the last table entry.

If *Synchronization* is set to *External Repeat* or *External Oneshot*, the behavior is similar except that the sequence is restarted when a low/high transition occurs at the Trigger Input #1. The exact time relative to the external trigger signal can be adjusted using the *Hold off* time. This value defines the delay between the trigger pulse and the restart of the sequence.

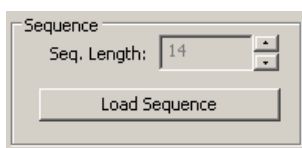
The external trigger signal can be used as timebase instead of the internal timer. In this mode the look-up-table is processed at the clock rate applied to Trigger Input #1. Turn *Timebase* to *External* to activate this function.

With the external timebase a restart of the sequence can be achieved by applying a TTL signal to Trigger Input #2. This input is not edge-triggered, therefore a high level of at least 100  $\mu s$  duration triggers a restart of the sequence on the next rising edge of Trigger Input #1.

### 5.3.3 Sequence Operation

The sequence mode is activated by double-clicking the *Sequence* sub-item of the A3XXX instrument. The sequence mode is very similar to the scrambling mode except that a customizable sequence is uploaded to the instrument. The sequence has to be stored in an ASCII file with decimal numbers ranging from 0 to  $2\pi$ . Each row represents an entry of the look-up-table, each of the five columns represents a waveplate position.

By pressing the *Load Sequence* button the ASCII file is opened, the waveplate settings are transferred to the instrument and the sequence is started. All other functionality is similar to the scrambling mode. You can find some sample sequences in the Examples\DemoSequences\_A3XXX subfolder of the polarizationNAVIGATOR™ folder.



### 5.4 A3300 Polarimeter Operation

The A3300 instrument is able to perform all polarimeter operations described for A1XXX and A2XXX (section ??) instruments.

### 5.5 A3000 Polarization Stabilization

In addition to the sequence, manual and scramble modes described *before* (section 5.3), the A3000 can be used to generate a fixed output SOP, even with varying input SOPs. By choosing the *Stabilize* sub-item of an active A3000 instrument, the settings for the stabilizer can be accessed.

By pressing the *Settings* button, several *control parameters of the SOP controller* (section 5.7) can be modified.

By clicking the *Stabilize* check mark, the controller can be stopped or resumed. When the *Criterion* is set to "Internal" (section 5.7), the controller generates a fixed, stable output SOP. When it is set to "Analog In", an appropriate external signal has to be provided and the A3000 will optimize the output SOP with respect to this feedback signal.

### 5.6 A3300 Polarization Stabilization

In addition to the sequence, manual and scramble modes described *before* (section 5.3), the A3300 can be used to generate specific output SOPs, even with varying input SOPs. By choosing the *SOP Stabilize* sub-item of an active A3300 instrument, the settings for the SOP stabilizer can be accessed. By default a list of four SOPs is shown, which can be replaced with an arbitrary list of SOPs by pressing the *Import* button. The imported file is expected to contain one normalized Stokes vector per line, with spaces or tabs as separators between the vector components. You can find some sample sequences in the Examples\DemoSOPTables\_A3300 subfolder of the polarizationNAVIGATOR™ folder. By clicking the *WP* checkbox, the corresponding waveplate angles are shown instead of the Stokes vectors.

By setting the appropriate check marks, the target SOPs can be shown (*Show Target SOPs*, red dots), as well as the SOPs actually generated



s1	s2	s3
1.00	0.00	0.00
0.00	1.00	0.00
-1.00	0.00	0.00
0.00	-1.00	0.00
0.00	0.00	1.00
0.00	0.00	-1.00

Import Export < > ☐ WP

(*Show Ctrl SOPs*, green dots) and the A3300 can be set to cycle through the list of SOPs with an adjustable delay between two successive SOPs (note that for high-speed cycling the *Trace* mode is more appropriate).

☒ Show Target SOPs  
☒ Show Ctrl SOPs  
☐ Auto Cycle (s): 0.20

By pressing the *Settings* button, several *control parameters* (section 5.7) of the SOP controller can be modified.

Settings

☐ Set-And-Forget Orth. SOP  
☒ Stabilize  
Wavelength (nm): 1550.000  
Criterion: SOP

The *Stabilize* check mark is set automatically, when choosing an SOP from the list or when activating the *Auto Cycle* or the *Set-And-Forget* feature. By unchecking or checking this option manually, the controller can be stopped or resumed. The *Set-And-Forget* mode activates the controller and stabilizes the current output SOP to the SOP present at the time of activation. By pressing the *Orth. SOP* button, the target SOP is replaced with its orthogonal SOP.

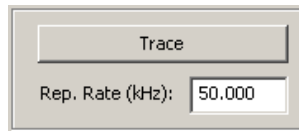
For optimum performance the operating wavelength should be entered in the corresponding text box.

The *Trace* mode is designed for high speed SOP cycling. Here an appropriate pattern of polarization controller settings is generated automatically, yielding the desired output SOPs. Once this pattern is found, it is repeated by the A3300 at the adjustable *Repetition Rate*, without any further SOP stabilization, i.e. without adaption to subsequent changes of the input SOP.

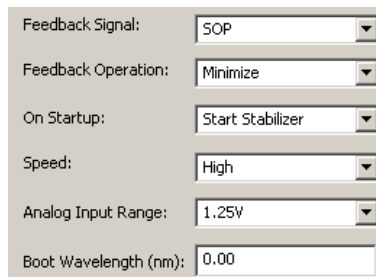
## 5.7 A3000/A3300 Control Parameters

By pressing the button *Settings* from the *SOP Stabilize* sub-item of an A3000/A3300 instrument, several startup options, as well as control parameters can be set. This dialog can also be accessed by choosing *Properties* from the A3000/A3300 instruments context menu and selecting the *Stabilizer Settings* tab.

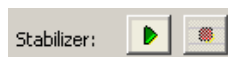
You can choose, whether the SOP stabilizer feature should be activated automatically *On Startup* or not, as well as the control *Speed* and the operating *Wavelength* on startup. In case of the A3000, you can choose



whether to use the "Internal" or an external ("Analog In") *Feedback Signal* and the *Feedback Operation* (i.e. whether to "Maximize" or to "Minimize" the feedback signal) as well as the *Analog Input Range* of the external signal.



By pressing the button with the green arrow/red circle, the stabilizer is started/stopped.



In addition, the internal control parameters can be overridden from this dialog. You can configure the control behaviour to optimize the controller to your particular system.

If you click on *Override Default Settings* on the Settings-dialog, you can enter the following values:

**Control Step Size:** Increase this parameter to make the control steps larger.

**Gradient Step Size:** The controller measures the gradient of the feedback signal with respect to the control parameters. This is done by dithering the control parameters. Increase this parameter to make the dithering steps larger.

**Coarse Threshold:** If the feedback signal differs too much from the optimum, the controller switches to the "coarse" mode, i.e. the control steps are temporarily increased to quickly move back into the optimum.

**Off Threshold:** If the deviation from the optimum is smaller than this value, the controller does not perform any control steps.

**Min Step Size:** Controls the minimum allowed control step size. Even if the gradient is small, the controller will at least make a control step of this size.

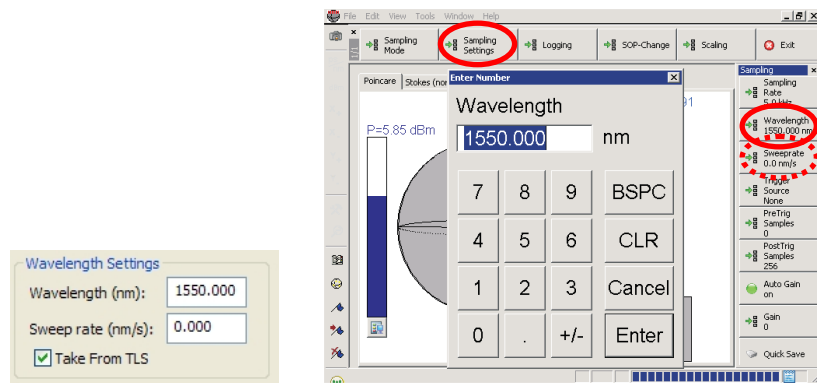
Note that you can only change these values if the controller is turned off.

## 6 Applications

### 6.1 Application: Polarimeter

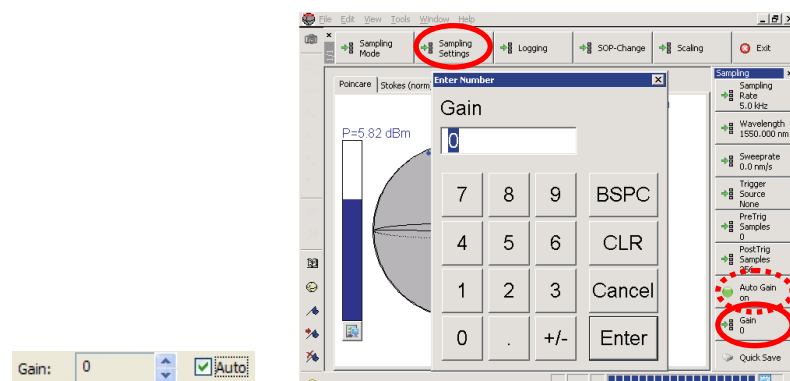
#### 6.1.1 Choosing the Wavelength

To obtain accurate measurement results the operation wavelength of the light source has to be chosen. If not already opened, open the Settings-window of the A1XXX/A2XXX/A3300 by clicking on the Settings-entry in the browser window. Enter the wavelength and choose a sweep rate of 0 nm/s. In the Integrated PC Mode open the corresponding button subset by clicking Sampling Settings.



#### 6.1.2 Auto Gaining

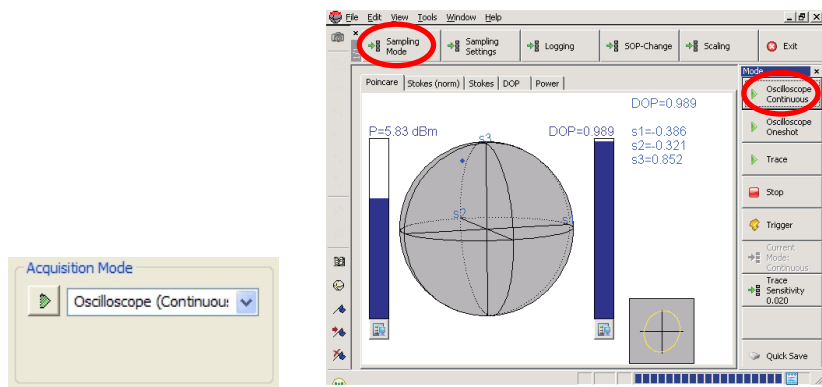
To provide a wide range of input power, the polarimetric receiver has 14 different input gain settings (0=lowest sensitivity, 13=highest sensitivity). Usually the instruments chooses the correct input gain settings to achieve optimum performance. You can suppress the gain switching by removing the check on the Auto-field next to the gain display.



#### 6.1.3 The Oscilloscope Mode

The default operation mode is Oscilloscope. In this mode data is sampled at a constant sampling rate. You can choose the desired number of samples. The sampling rate together with the number of samples determines the observed time scale. The number of samples is defined by setting the Post-Trigger Samples value, even when no external trigger is used.

There are two options in this mode: *Continuous* and *Oneshot*. In the continuous mode, the measurement is restarted after receiving a trace. In



oneshot mode the acquisition has to be manually (re)started by pressing the button next to the list box or by pressing the Trigger button, when using the Integrated PC Mode. To stop measuring in continuous mode select Hold from the drop-down menu or by pressing the Stop button respectively.

#### 6.1.4 Edge Detection

If the SOP changes rapidly during the observed time frame, a reduced degree of polarization (DOP) may be observed. This happens when the SOP instantaneously changes within a sampling interval. Although this is a correct readout since the DOP is in fact reduced within that short moment it is sometimes desired to avoid sampling on those edges.

Specifically this applies to measurements, where the SOP is expected to stay in fixed positions for certain intervals and change very quickly in between (e.g. when using an adaptif PHOTONICS A3XXX as a scrambler). If no synchronization method is used, the abovementioned effect will occur.

Activate Lock to Edges to detect and avoid such edges.

NOTE: This operation uses 6 x oversampling and is thus only available for sampling rates below 160 kHz.

#### 6.1.5 Triggering

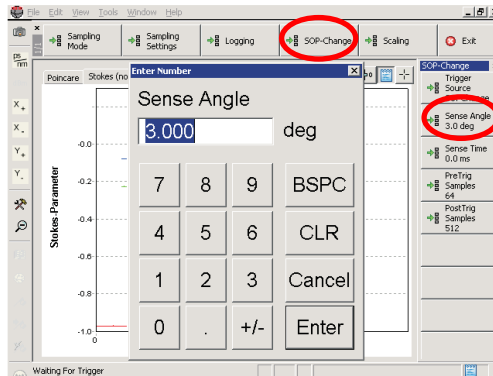
You can synchronize the start of a measurement cycle to certain events such as an external trigger signal.

Select *TTL High* or *TTL Low* from the Trigger list box to choose the desired trigger edge of an externally applied digital signal. The signal has to be applied to the BNC input named *Trig. In*. The actual measurement is performed continuously, so the trigger event defines the portion of the measured data stream to be shown. You can set the number of samples to be stored from right before the trigger event (Pre-Trig. Samples) and right after the trigger event (Post-Trig. Samples).

Trigger: SOP Change Sensitivity

Angular Difference (deg): 3.0

Time Interval (ms): 10.000

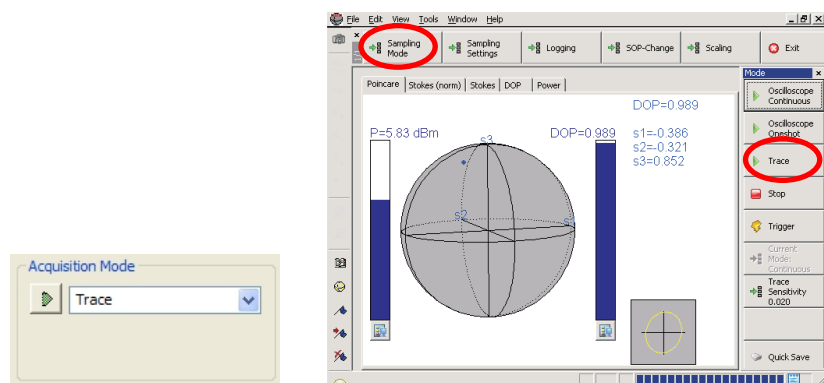


Choose *SOP Change* if you want to trigger on a changing SOP. You can set the sensitivity by pressing on the *Sensitivity* button. In the example below, a trigger event is detected when the SOP changes by at least 3 degree on the Poincaré sphere within a time interval of 10 ms. Note that you could achieve the same sensitivity by choosing different values (e.g. 1,5 deg and 5 ms). However this may cause false trigger events due to measurement noise.

You will find the trigger parameters in the Sampling Settings section. In the External PC Mode the SOP Change parameters, like angular sensitivity are accessed by pressing the *Sensitivity* button, which will show up, when the SOP Change mode is active. In the Integrated PC Mode they are located in the SOP Change section. You can also set the number of samples to be stored from right before the SOP change event (Pre-Trig. Samples) and right after the SOP change event (Post-Trig. Samples).

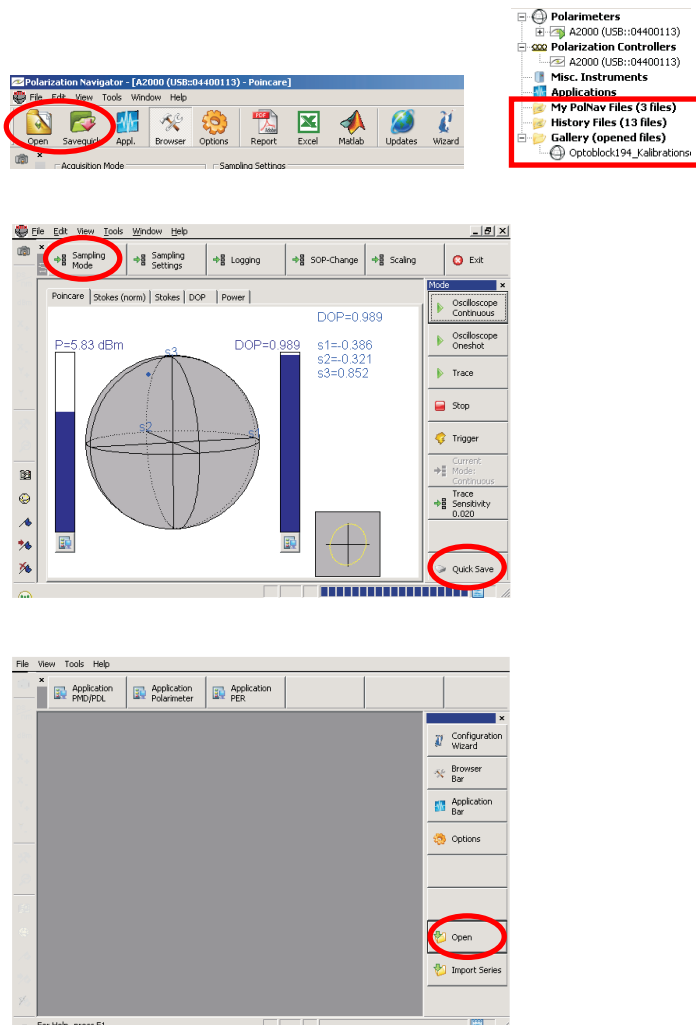
## 6.1.6 The Trace Mode

In Trace mode data is sampled with a fixed sampling rate of 2.5 kHz and stored only if the SOP has changed by a certain amount. The displayed buffer operates like a FIFO (first-in-first-out) buffer. Thus the oldest SOPs are discarded when new SOPs are stored. The number of SOPs stored is controlled by the Post-Trig. Samples value. Switch to the Stokes-window and change the input polarization to see how SOPs are stored in this mode. You can clear the current trace by choosing *Clear Measurement* from the *Edit* menu or by pressing F2.



### 6.1.7 Saving Measurements (Snapshots)

You can save measurement data using the *save as* option from the file menu and providing a filename. You can also use the Quick Save/Savequick button to assign an automatic filename from the current date and an increasing counter and store it in your `\My Documents\My PolarizationNavigator Files` folder. The files can be accessed through the file *Open...* dialog from the *File*, by pressing the Open button or by opening the corresponding file from the Explorer. Open files will be stored in the Gallery and can be accessed from the browser bar. Alternatively you can make a *snapshot* by pressing the camera button on the left side of a window. The current measurement is transferred to the Gallery shown in the browser window, but not saved at this time. This allows you to compare different measurements with each other. In addition, the most recent files will be placed in your `\My Documents\My PolarizationNavigator History` folder. The content of the `\My Documents\My PolarizationNavigator Files` and `\My Documents\My PolarizationNavigator History` folders can also be accessed from the respective entries in the browser bar.



NOTE: When you press the camera button a new gallery entry is created and a new window is opened. The polarimeter window is still active in the background. You can bring it to the foreground again by either

clicking on the corresponding entry in the browser or by clicking in the Windows menu or by pressing CTRL+F6 one or more times.

NOTE: The gallery is not stored on the harddisk. You have to click on Save or Save As to save the measurement of the top-most window.

### 6.1.8 The Poincaré View

As described before, you can chose different views for the same measurement data. One of these views is the Poincar sphere window. You can rotate the sphere by clicking onto the sphere and dragging the mouse with the left mouse button held down. The tool buttons on the left side of the main window have the following functions:

- **Show Gallery Measurements** – Displays all measurements of the gallery in the same sphere.
- **Line/Point Display** – Toggles between line-mode (all SOPs are connected by lines) and point mode (each SOP is displayed as isolated point).
- **Show Marker** – Displays stored markers (see next button)
- **Store Marker** – Adds the current SOP to a list of markers. If more than one marker is stored, the angular difference is displayed on the right side of the window. Markers are cleared if another display tab (graph view) is chosen.
- **Clear All Markers** - Clears the list of markers
- **Show PER** - The polarization extinction ratio (PER) of light in a PMF can be determined by creating circle trajectories on the Poincaré sphere. This can be done in Real-time mode by either changing the wavelength or by slightly stretching or twisting the PMF. When you see the circle trajectory press this button to calculate the PER. Press the button again to remove the displayed PER.



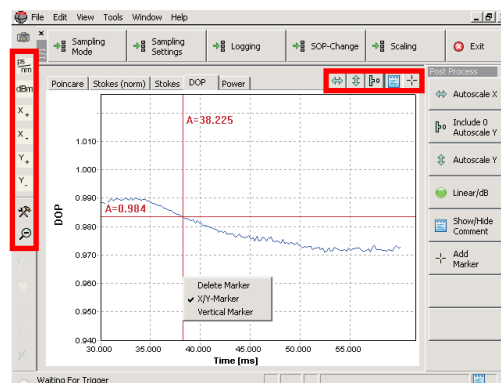
These buttons may not always be shown. You can toggle this Graph Bar from the *View*.

### 6.1.9 Graph Views

Graph views are used to display the normalized Stokes parameters, the DOP and the power versus time. Use the mouse to zoom into the plot by clicking and dragging. Double-click the graph area to reset the zoom. Double-click the trace to set the axis properties. By this you can manually set the axis ranges. The buttons to the top right of the window have the following functions:

- **Autoscale X-Axis** - Chooses the optimum X-scaling to display the whole plot.
- **Autoscale Y-Axis** – Chooses the optimum Y-scaling to display the whole plot.
- **Include Zero** – When autoscaling is active, the Y-scaling is chosen to include 0.
- **Show/Hide Comment** – Toggles a Window containing information about the measurement. In the polarimeter application there are currently no informations shown here.
- **Add Marker** – Creates a Marker for the current measurement.

Markers can be moved by left-clicking them and holding the left mouse button while moving the marker. If the current graph view contains a single trace (DOP, power), the marker will be an X/Y-marker, i.e. it will stick to the trace and display the X and Y values for the marked point on the trace. If the graph contains several traces (Stokes parameters), the marker will be a Vertical Marker, i.e. it will just mark and display an X value. When switching between the graph view tabs, the markers will stay at their chosen X positions and change their vertical behavior, depending upon the type of data displayed. The marker behavior can be toggled manually from the marker context menu, which is brought up by right-clicking the marker. From this menu, the marker can be deleted as well. Markers will be erased if a new measurement is performed. Before working with markers, it is therefore recommended to stop the measurement by setting the acquisition mode to Hold in the External PC mode or by pressing the Stop button from the Sampling Mode vertical button set in the Integrated PC Mode.



The buttons on the left side of the window have the following functions:

- **Toggle X-axis unit** – Toggles between the display of the appropriate unit (e.g. ms, nm) and the display of an increasing counter (number datapoints).
- **Linear/dB power plot** – Toggles between a logarithmic (dB) and a linear power scale.
- **X-Unit** – Selects the desired unit modifier (e.g. pm, nm etc.)
- **Y-Unit** – Selects the desired unit modifier (e.g. nW, mW etc.)
- **Graph Properties** – Opens the *Graph Properties* dialog box.
- **Restore Last Scaling** - If zoomed into a plot, this restores the previous scaling.

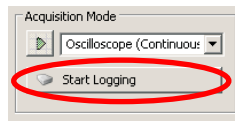
These buttons may not always be shown. You can toggle this Graph Bar from the *View*.

#### 6.1.10 Data Logging

The adaptif PHOTONICS instruments support data logging, i.e. you can define an interval at which measurements will be stored. In between the instrument continues to perform measurements and refresh the display. Before starting a logging session you should set appropriate parameters like sampling rate, number of samples per measurement (Post-Trig. Samples) and gain.



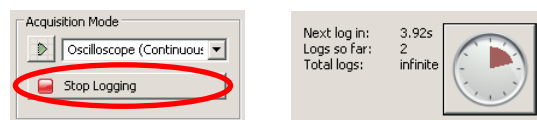
In the External PC Mode, a wizard will guide you through the setup of the actual logging parameters after you press the Start Logging button.



First you have to choose, whether to store the measurements in a single file or as separate files. A single document should be chosen only for small logging series, since all data is stored in memory until the logging sequence has stopped and saved to disk then. Long logging series should be stored as separate files, since no memory restrictions apply, except of the total free space on the hard disk. In addition the measurements are saved to disk each, which can be fortunate in case of e.g. a power failure.

The next step is to set the logging interval in seconds, the maximum number of measurements to log and the filename body, which is used as the first part of the filenames, followed by an increasing counter. If Maximum Logs is set to zero, measurements will be logged until you press Stop logging.

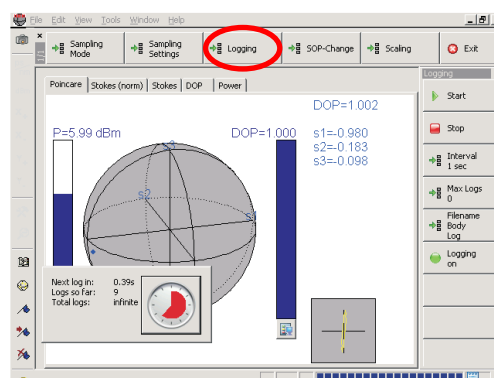
During the logging process there will appear a small window, informing about the current logging state.



Once the logging has been stopped, there will be a dialog, allowing you to immediately open the logging series. Opening a very long series that has been saved to separate files can take some time.

When a logging series has been opened, there will be a horizontal slider below the data figures, allowing you to navigate within the series.

In the Integrated PC Mode, the logging parameters can be set directly in the Logging section.



When the sampling mode is set to Trace, the logging function acts slightly different. Instead of performing measurements at predefined intervals, starting logging in trace mode will stream the measured data into an ASCII file. In this file you will find rows containing the three Stokes parameters, the power and the DOP.

## 6.2 Application: PDL/PMD

Use this application for PDL/PMD sweep measurements. It uses a continuous sweep of the tunable laser source (TLS) to measure the following parameters versus wavelength:

- PDL, "Best Case" SOP (i.e. SOP with the maximum transmission coefficient, denoted "PDL<sub>PSP</sub>")
- P<sub>min</sub>/P<sub>max</sub>
- Power/Loss
- DGD, PSP, second-order PMD (denoted "PMD<sub>2nd</sub>")

See *Measurement Setup Using the A2000* (section 6.2.9) or *Measurement Setup Using the A1000/A3XXX* (section 6.2.10) for details on how to connect the DUT and the trigger cables.

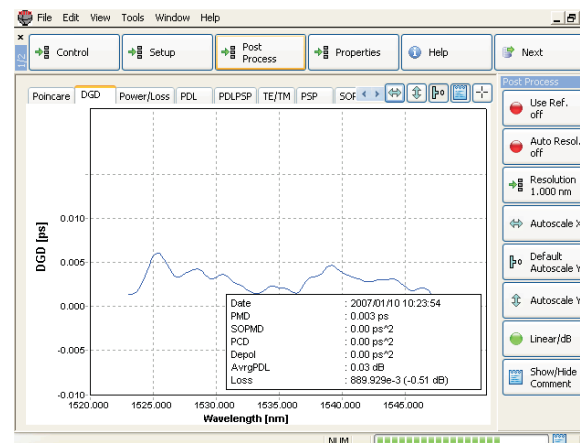
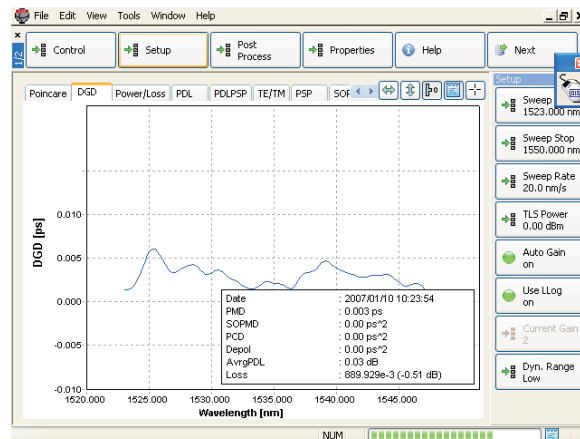
Shown in this section are screenshots of the polarizationNAVIGATOR™ software running in the Integrated PC Mode, which is used for instruments of the Axxx-B3/R3 series. When clicking buttons from the top row in this mode, the button columns to the right will change. Sometimes there are more function buttons than the number of available slots in the respective row or column. In that case there will be a button labeled *more*, which will replace the row/column with another set of buttons. If the polarizationNAVIGATOR™ is running on a desktop or notebook PC with adaptif PHOTONICS instruments connected to it, it will be running in External PC Mode, which basically supports the same functions with a slightly different screen layout. Sections of screenshots from the polarizationNAVIGATOR™ in the External PC Mode are shown for specific functions as well.

Before starting a measurement you should check or set the measurement parameters.

### 6.2.1 Application Setup Parameters

Start wavelength (nm):	Defines the start of the wavelength sweep.
Stop wavelength (nm):	Defines the stop of the wavelength sweep.
Sweep rate (nm/s):	Defines the nominal sweep rate of the laser. Note, that the number of data points changes with the sweep rate since the sampling rate is constant. The resulting number of samples are shown in the field "Samples".
Laser Power (dBm):	Defines the optical output power of the laser source.
Dynamic Range (Low/ Med/ High):	Sets up the power dynamic range of the measurement. A dynamic range of approximately 20dB can be achieved within a single laser sweep. Higher dynamic ranges can be achieved by performing several sweeps with different input amplifier gain settings.
Samples:	Shows the estimated number of samples.
Current Gain:	Shows the current gain setting of the input amplifiers (0=lowest sensitivity, 13=highest sensitivity). Each step changes the allowed optical input power range by approximately 3dB.
Auto Gain:	Defines if the next measurement is done using the autogaining feature, otherwise the measurement will be done using a fixed gain. Autogaining is recommended for DUTs with high dynamic loss range (e.g. filters).

- Use LLOG: Agilent tunable laser sources provide a built-in optical wavemeter to increase wavelength accuracy. Check this box to use the internal wavemeter functionality ("Lambda Logging").
- Reference: If a reference measurement is done you can select whether it will be used for the measurement or not.
- Resolution (nm): Defines the width of the averaging window as well as data interleaving. Use smaller values for a better wavelength resolution.
- Pwr. Resolution (nm): Defines the width of the averaging window for the power trace. Use smaller values for a better wavelength resolution. Use "Default" to use the same resolution as for the other traces.



**Measurement Setup**

Start Wavelength (nm): 1523.000      Current Gain: 2

Stop Wavelength (nm): 1550.000      Samples: 0

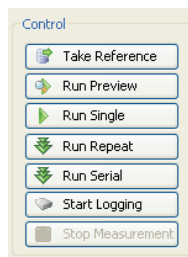
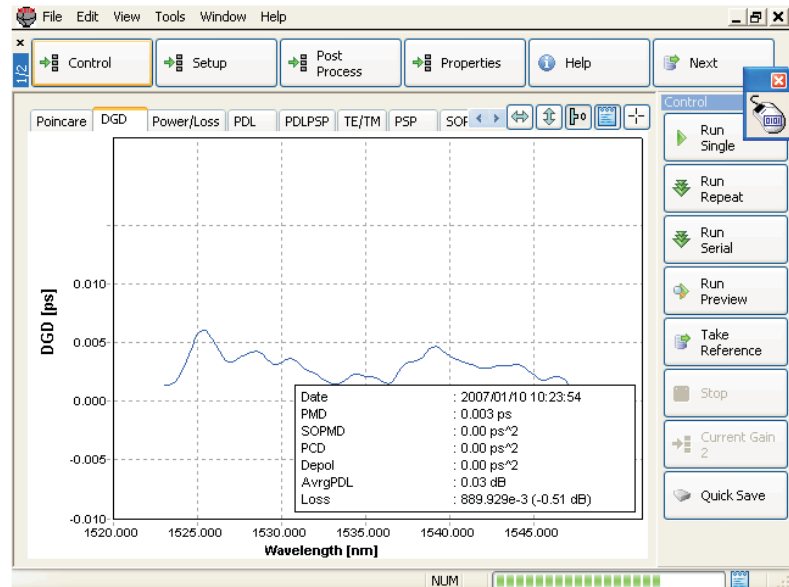
Sweep Rate (nm/s): 20.0      ☒ Auto Gain

Laser Power (dBm): 0.00      ☒ Use LLOG

Dynamic Range: Low

## 6.2.2 Performing measurements

In the Integrated PC Mode measurements are performed by using the buttons in the *Control* subset, while in External PC Mode a these buttons are always shown.



## 6.2.3 Performing a preview measurement

Connect the DUT and enter the desired settings (see below). Then press the "preview" button. A preview measurement is performed and a power/loss trace is acquired.

## 6.2.4 Performing a non-referenced measurement

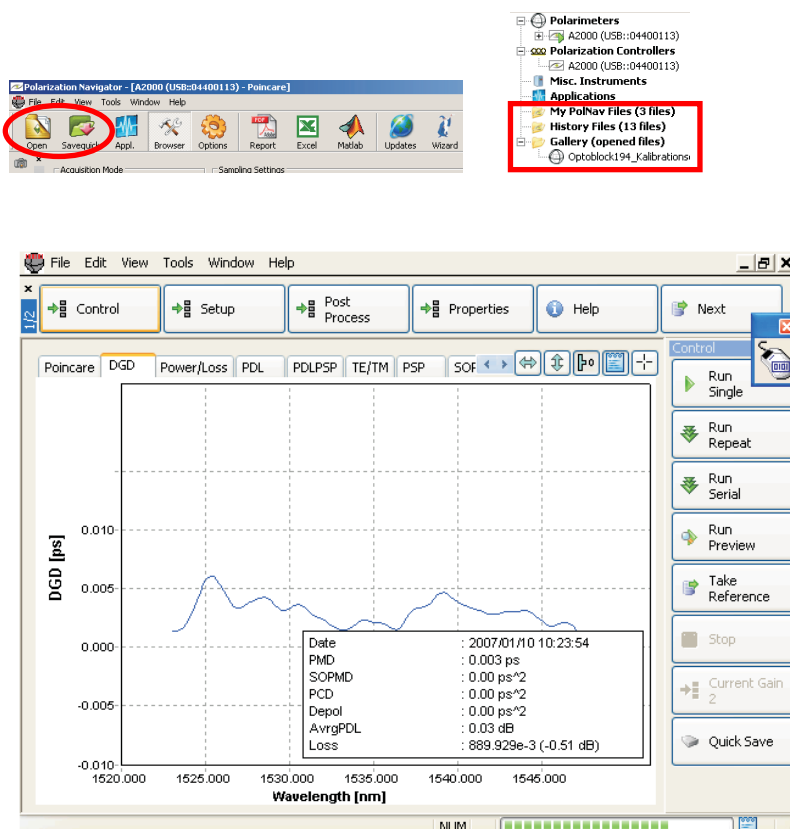
Connect the DUT and enter the desired settings (see below). Then press the "Single Measurement" button or the "Repeat Measurement" button. The accuracy of the DGD will be limited to approximately 0.1ps.

## 6.2.5 Performing a referenced measurement

Connect a patchcord to the DUT ports and perform a reference measurement by pressing the "Take Reference" button. Then connect the DUT and enter the desired settings (see below). Then press the "Single Measurement" button or the "Repeat Measurement" button. Best performance will be achieved in this mode.

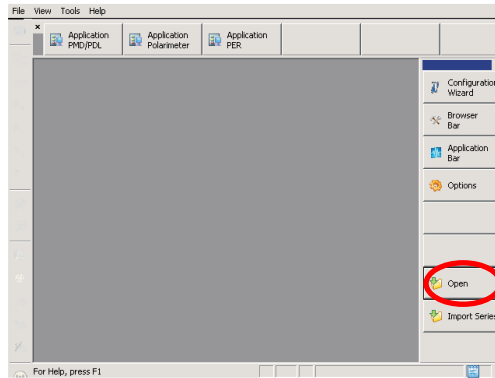
## 6.2.6 Saving Measurements (Snapshots)

You can save measurement data using the *save as* option from the file menu and providing a filename. You can also use the Quick Save/Savequick button to assign an automatic filename from the current date and an increasing counter and store it in your *\My Documents\My PolarizationNavigator Files* folder. The files can be accessed through the file *Open...* dialog from the *File*, by pressing the Open button or by opening the corresponding file from the Explorer. Open files will be stored in the Gallery and can be accessed from the browser bar. Alternatively you can make a *snapshot* by pressing the camera button on the left side of a window. The current measurement is transferred to the Gallery shown in the browser window, but not saved at this time. This allows you to compare different measurements with each other. In addition, the most recent files will be placed in your *\My Documents\My PolarizationNavigator History* folder. The content of the *\My Documents\My PolarizationNavigator Files* and *\My Documents\My PolarizationNavigator History* folders can also be accessed from the respective entries in the browser bar.



NOTE: When you press the camera button a new gallery entry is created and a new window is opened. The polarimeter window is still active in the background. You can bring it to the foreground again by either clicking on the corresponding entry in the browser or by clicking in the Windows menu or by pressing CTRL+F6 one or more times.

NOTE: The gallery is not stored on the harddisk. You have to click on Save or Save As to save the measurement of the top-most window.



## 6.2.7 Data Logging

The adaptif PHOTONICS instruments support data logging, i.e. you can define an interval at which measurements will be stored. In between the instrument continues to perform measurements and refresh the display. Before starting a logging session you should set appropriate parameters like sampling rate, number of samples per measurement (Post-Trig. Samples) and gain.

In the External PC Mode, a wizard will guide you through the setup of the actual logging parameters after you press the Start Logging button.

First you have to choose, whether to store the measurements in a single file or as separate files. A single document should be chosen only for small logging series, since all data is stored in memory until the logging sequence has stopped and saved to disk then. Long logging series should be stored as separate files, since no memory restrictions apply, except of the total free space on the hard disk. In addition the measurements are saved to disk each, which can be fortunate in case of e.g. a power failure.

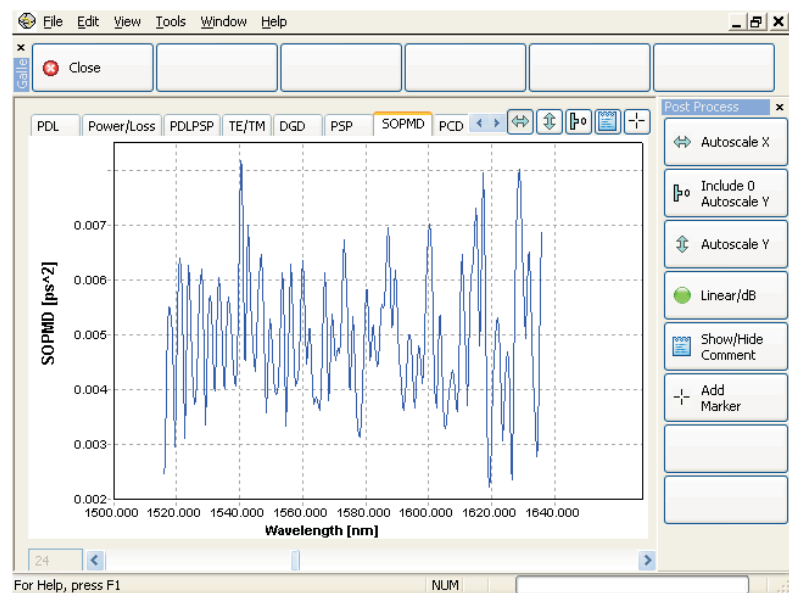
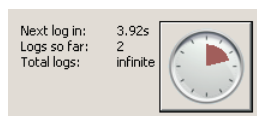
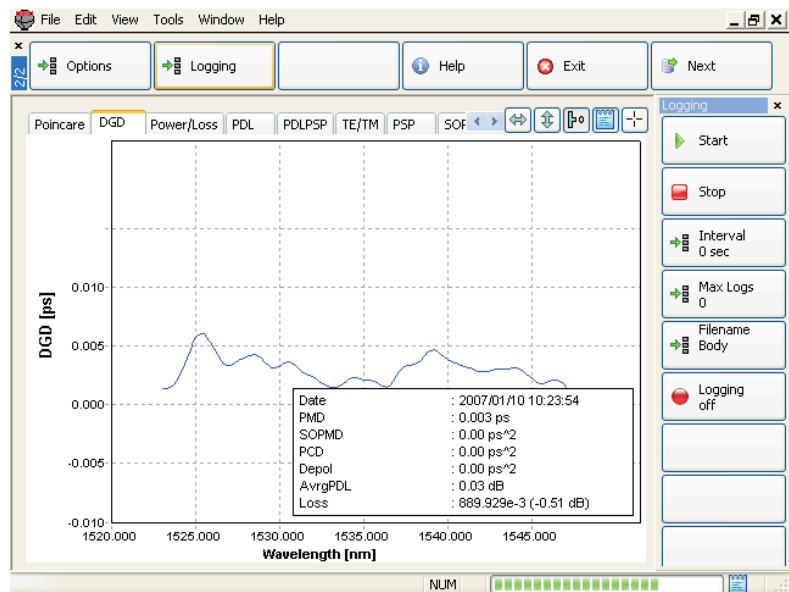
The next step is to set the logging interval in seconds, the maximum number of measurements to log and the filename body, which is used as the first part of the filenames, followed by an increasing counter. If Maximum Logs is set to zero, measurements will be logged until you press Stop logging.

In the Integrated PC Mode, the logging parameters can be set directly in the Logging section.

During the logging process there will appear a small window, informing about the current logging state.

Once the logging has been stopped, there will be a dialog, allowing you to immediately open the logging series. Opening a very long series that has been saved to separate files can take some time.

When a logging series has been opened, there will be a horizontal slider below the data figures, allowing you to navigate within the series.



## 6.2.8 Measurement Raw Data

Raw data can be stored together with the measurement result if the option "Keep Raw Data" is selected. This data includes the measured SOPs at the output of the DUT and the assumed SOPs at the input of the DUT which are derived from the reference measurement. In case of the referenced measurement, Mueller matrices for each wavelength are also included. This additional raw data cannot be displayed by the Polarization Navigator. It can be exported to an ASCII-file or to a MATLAB .mat-file by clicking on "File/Export".

It can also be accessed by loading a .pbin-file into the MATLAB workspace:

```
Data=PBinRead('Result.pbin');  
figure;plot(Data.Lambda,Data.MuellerMatrix);  
figure;plot(Data.SOPInput(:,1),Data.SOPInput(:,2:5));  
figure;plot(Data.SOPOutput(:,1),Data.SOPOutput(:,2:5));
```

The Mueller Matrix elements are stored in 16 columns. Each row belongs to a different wavelength. The Mueller Matrix of the 10th row can be derived by the following command:

```
M= reshape(Data.MuellerMatrix(10,:),4,4)';
```

You can convert the Mueller matrix data into Jones space using the following MATLAB command:

```
Jones=Mueller2Jones(Data.MuellerMatrix);
```

The resulting matrix contains a row for each wavelength. Each 4 elements of a row form a Jones matrix, where the first 2 elements contain the top row of the Jones matrix and the next 2 elements contain the bottom row of the Jones matrix.

Also note that the input SOP is cycled through a system of 6 input SOPs. If you want to access only one SOP out of the whole system use following command:

```
nSystem=3;  
figure;  
plot( Data.SOPOutput(nSystem:6:end,1),  
      Data.SOPOutput(nSystem:6:end,2:5) );
```

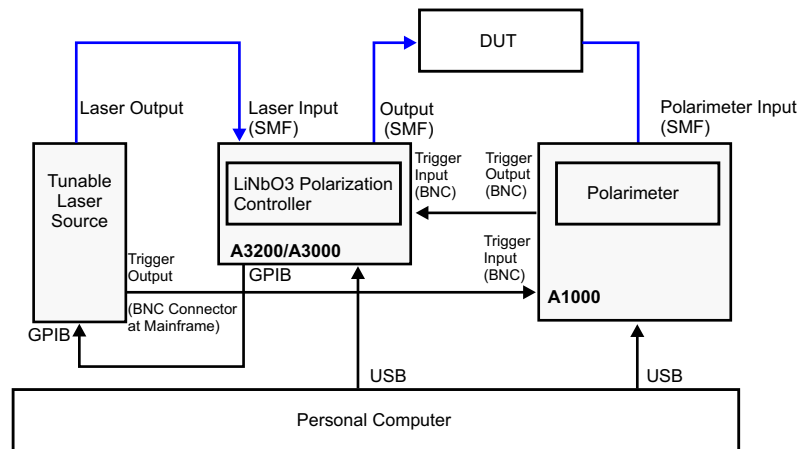
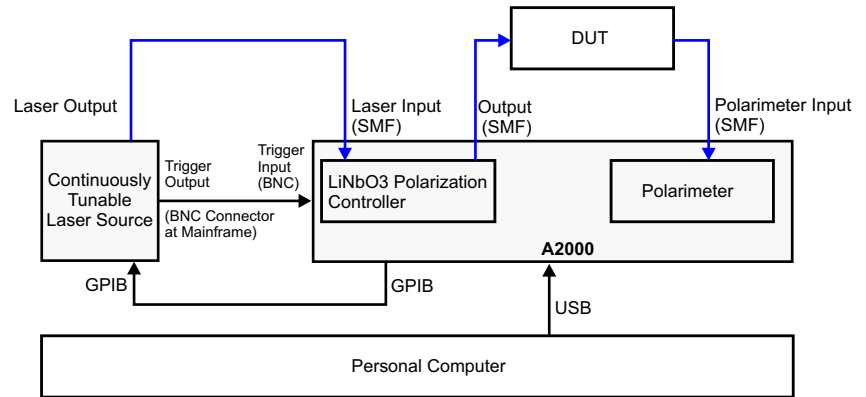
## 6.2.9 Measurement Setup Using the A2000

The A2000 combines polarization control functions and polarimetric measurement functions within a single instrument. Therefore optical connections are reduced to a minimum. A tunable laser source (TLS) is connected to the input and the device under test (DUT) is connected to the corresponding optical ports.

## 6.2.10 Measurement Setup Using the A1000/A3xxx

PMD/PDL measurements are also possible with a combination of A3XXX (polarization controller) and A1000 (polarimeter). Since the instruments need to be synchronized some more electrical connections for triggering are necessary (see figure).





### 6.3 Application: PDL/PMD (Stepped)

Use this application for PDL/PMD stepped measurements. It uses a stepped sweep of the tunable laser source (TLS) to measure the following parameters versus wavelength:

- PDL, "Best Case" SOP (i.e. SOP with the maximum transmission coefficient, denoted "PDL<sub>PSP</sub>")
- P<sub>min</sub>/P<sub>max</sub>
- Power/Loss
- DGD, PSP, second-order PMD (denoted "PMD<sub>2nd</sub>")

See *Measurement Setup Using the A2000* (section 6.2.9) or *Measurement Setup Using the A1000/A3XXX* (section 6.2.10) for details on how to connect the DUT and the trigger cables.

#### 6.3.1 Performing a non-referenced measurement

Connect the DUT and enter the desired settings (see below). Then press the "Single Measurement" button or the "Repeat Measurement" button.

#### 6.3.2 Performing a referenced measurement

Connect a patchcord to the DUT ports and perform a reference measurement by pressing the "Take Reference" button. Then connect the

DUT and enter the desired settings (see below). Then press the "Single Measurement" button or the "Repeat Measurement" button. Best performance will be achieved in this mode.

### 6.3.3 Measurement Raw Data

Refer to *Measurement Raw Data* (section 6.2.8) to learn about how raw data is embedded into the .pbin-files.

### 6.3.4 Application Setup Parameters

Start wavelength (nm):	Defines the start of the wavelength sweep.
Stop wavelength (nm):	Defines the stop of the wavelength sweep.
Step Size (nm):	Defines the wavelength step size for the measurement.
Laser Power (dBm):	Defines the optical output power of the laser source.
Current Gain:	Shows the current gain setting of the input amplifiers (0=lowest sensitivity, 13=highest sensitivity). Each step changes the allowed optical input power range by approximately 3dB.
Samples:	Shows the estimated number of samples.
Reference:	If a reference measurement is done you can select whether it will be used for the measurement or not.
Resolution (nm):	Defines the width of the averaging window as well as data interleaving. Use smaller values for a better wavelength resolution.

## 6.4 Application: PER/PMF Crosstalk

Use this application for crosstalk measurements in polarization maintaining fibers (PMF). Typically the light inside a PMF has to be guided either in the slow or in the fast axis. Usually this can only be achieved to some extent and the signal inside the PMF can be divided into two components guided in the fast and the slow axis. The power ratio between these two components is called polarization extinction ratio (PER). Typical values are between 20dB and 40dB meaning that the power in the "wrong" axis is 20dB (40dB respectively) below the light in the desired axis.

In case of limited PER the output polarization will move on a small-circle on the Poincaré sphere when mechanically disturbing the PMF or when changing the wavelength of the source. The radius is a measure for the PER. This application measures the radius of the trajectory of the output polarization and calculates the PER. A laser source is used as stimulus and the trajectory can either be generated by continuously changing the source wavelength or by disturbing the PMF (either manually or using A1210 Thermal Cycling Unit).

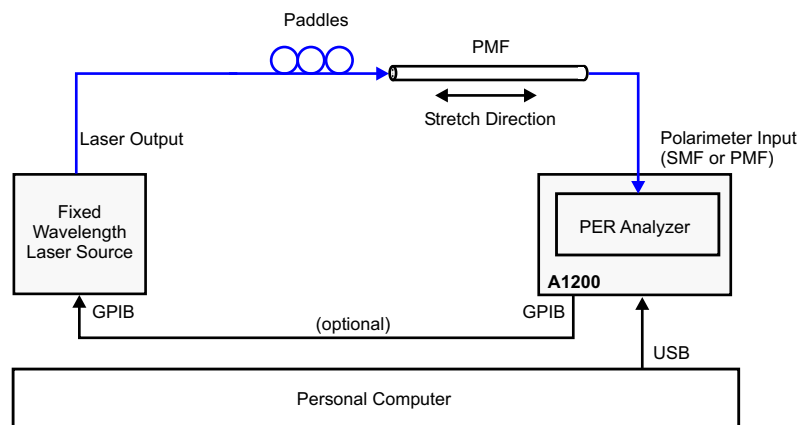
For details, please refer to the following sections:

- *Manual PER Measurement (PMF-stretching)* (section 6.4.1)
- *Swept Wavelength Measurement (tunable laser source needed)* (section 6.4.2)
- *Using a single A1210 Thermal Cycling Unit* (section 6.4.3)
- *Using two A1210 Thermal Cycling Unit (splice alignment)* (section 6.4.4)
- *Using an FSM-45PM Fujikura PM Splicer* (section 6.4.5)

#### 6.4.1 Application: PER/PMF Crosstalk (Manual PER Measurement)

Use this application for crosstalk measurements of polarization maintaining fibers (PMF) using a laser source at a fixed wavelength and by stretching/disturbing the PMF manually. The crosstalk is often expressed by the Polarization Extinction Ratio (PER) which is given by the ratio between the power levels of the two PMF axes (typically expressed in dB).

Connect the instrument and the PMF according to the following setup:



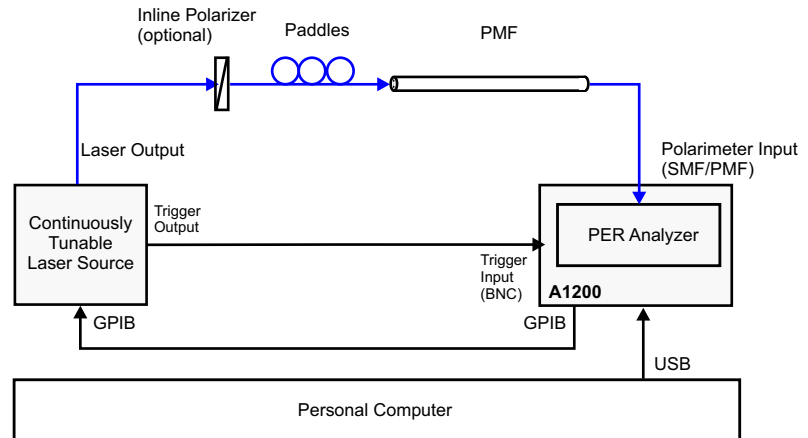
To optimize the PER inside the PMF follow these steps:

- Setup your device so that coherent light is guided through the PMF (e.g. turn on your laser diode or connect a tunable laser source to the PMF).
- Start the PER-application by double-clicking it.
- Enter the correct wavelength of the laser source
- Click on "PER Manual"
- Gently stretch the PMF so that a yellow circle appears. Try to make a full circle, then the PER-fit will be most accurate.
- The number displayed on the screen is the current PER.
- Once a PER value is stable, you can click on "PER Live" for real-time alignment.
- Now the current PER is measured in realtime based on the recently stored reference.
- Optimize the input polarization into the PMF by trying to move the blue spot into the center of the display which indicates the optimum input polarization.
- If you think you have reached the optimum, you can repeat the measurement by clicking on "PER Manual" and stretching the fiber again.

#### 6.4.2 Application: PMF Crosstalk (Swept Wavelength)

Use this application for crosstalk measurements in polarization maintaining fibers (PMF) using a swept laser source. The crosstalk is often expressed by the Polarization Extinction Ratio (PER) which is given by the ratio between the power levels of the two PMF axes (typically expressed in dB).

Connect the instrument and the PMF according to the following setup<sup>1</sup>:



To optimize the PER inside the PMF follow these steps:

- Setup your device so that light is guided through the PMF. If you connected your laser source using GPIB it will be controlled automatically. Otherwise use the manual mode and setup the laser so that it permanently sweeps over the desired wavelength range (typically 5nm to 10nm). The sweep speed should be around 40 nm/s.
- If you use an Agilent laser source you have to configure it before so that it appears under "Light Sources" in the browser. Please run the configuration wizard before to install the laser source properly.
- Start the PER-application by double-clicking it.
- Enter the correct center wavelength and the sweep range.
- Click on "PER WL Scan"
- Now the current PER is measured in realtime by continuously evaluating the circle-trajectory.
- Optimize the input polarization into the PMF by trying to minimize the radius of the circle.
- Once a PER value is stable, you can click on "PER Live" for real-time alignment.
- Now the current PER is measured in realtime based on the recently stored reference.

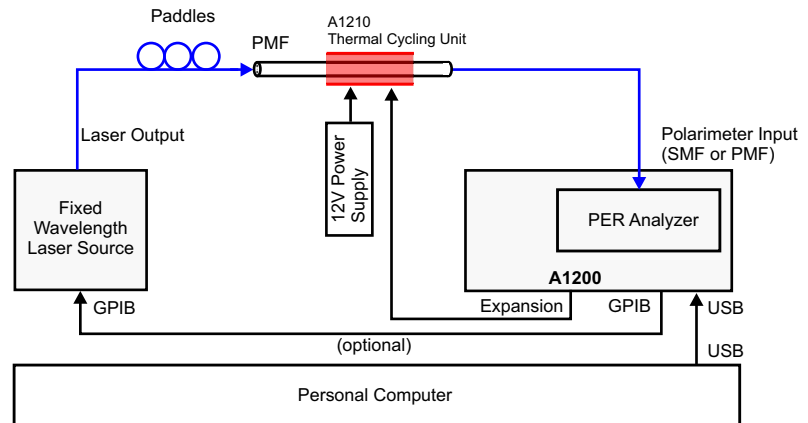
<sup>1</sup> Many tunable laser sources have a PMF output. Therefore, the limited PER inside this output PMF can reduce measurement performance. An inline polarizer can reduce this effect.

- Optimize the input polarization into the PMF by trying to move the blue spot into the center of the display which indicates the optimum input polarization.

#### 6.4.3 Application: PER/PMF Crosstalk (Using a single A1210 Thermal Cycling Unit)

Use this application for crosstalk measurements of polarization maintaining fibers (PMF) using a laser source at a fixed wavelength and an A1210 to automatically heat up and cool down the PMF.

Connect the instrument and the PMF according to the following setup:



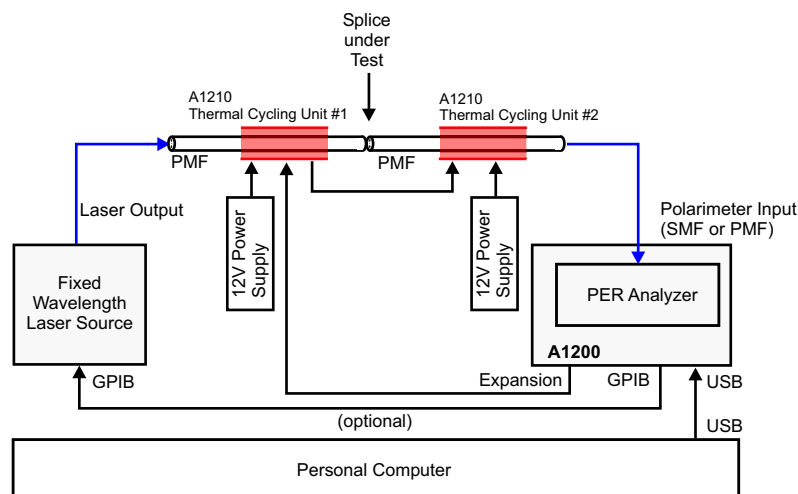
To optimize the PER inside the PMF follow these steps:

- Setup your device so that coherent light is guided through the PMF (e.g. turn on your laser diode or connect a tunable laser source to the PMF).
- Start the PER-application by double-clicking it.
- If the Thermal Cycling Unit is detected, the heater 1 should appear as "off" in the "Fiber Heater Status" area.
- Enter the correct wavelength of the laser source
- Click on "PER (Heater)"
- The A1210 is starting the temperature cycle by heating up the PMF (LED=red) and then cooling down the PMF again (LED=green). Then the device is turned off (LED=off).
- The number displayed on the screen is the current PER.
- Once a PER value is stable, the software switches to the "PER Live" mode for realtime alignment.
- Now the current PER is measured in realtime based on the recently stored reference.
- Optimize the input polarization into the PMF by trying to move the blue spot into the center of the display which indicates the optimum input polarization.
- If you think you have reached the optimum, you can repeat the measurement by clicking on "PER (Heater)" again.

#### 6.4.4 Application: PER/PMF Crosstalk (Using two A1210 Thermal Cycling Unit)

Use this application for characterizing splices between two polarization maintaining fibers. In that configuration, two A1210 Thermal Cycling Unit are needed (one for each PMF).

Connect the heating devices to the A1200 according to the following setup:



To optimize the splice angle follow these steps:

- Setup your device so that coherent light is guided through the PMF (e.g. turn on your laser diode or connect a tunable laser source to the PMF).
- Start the PER-application by double-clicking it.
- If the Thermal Cycling Unit are both detected, the heater 1 and the heater 2 should appear as "off" in the "Fiber Heater Status" area.
- Enter the correct wavelength of the laser source
- Click on "Splice Align"
- The first A1210 is starting the temperature cycle by heating up the PMF (LED=red) and then cooling down the PMF again (LED=green). Then the device is turned off (LED=off). After that, the second A1210 is doing a temperature cycle.
- The number displayed on the screen is the current PER/Splice Angle.

#### 6.4.5 Application: PER/PMF Crosstalk (Using an FSM-45PM Fujikura PM Splicer)

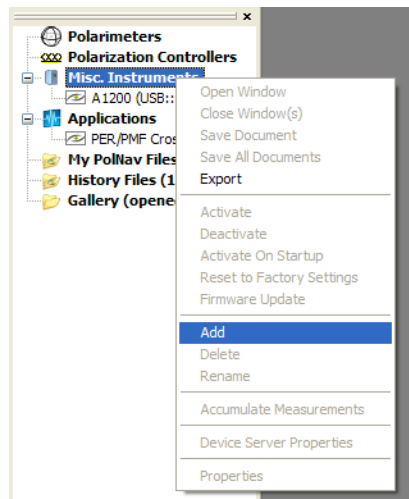
You can use the A1200 PER-Analyzer in combination with a Fujikura FSM-45PM splicer to automatically optimize the splice angle. You will need the following equipment:

- Adaptif A1200 PER-Analyzer
- 2 x Adaptif A1210 Thermal Cycling Units
- Fujikura FSM-45PM Splicer (Firmware revision higher than 1.37)

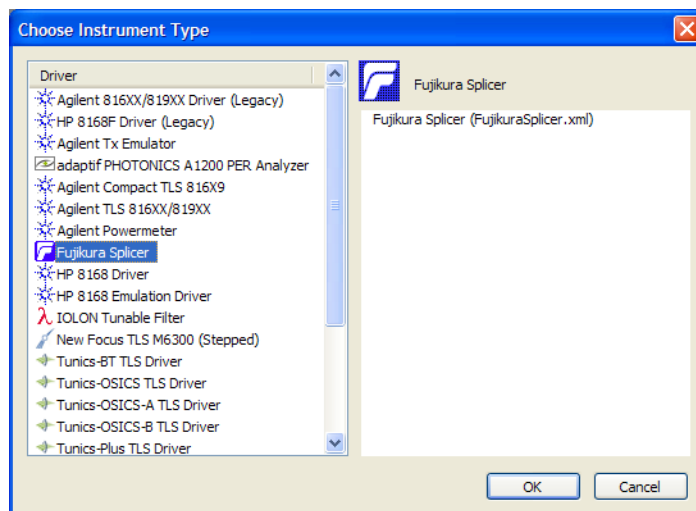
The measurement setup is very similar to the setup shown in chapter *Using two A1210 Thermal Cycling Unit (splice alignment)* (section 6.4.4). In addition, connect the splicer using an RS-232 null-modem cable to the PC.

Use the following steps to configure the polarizationNAVIGATOR™ to use the splicer:

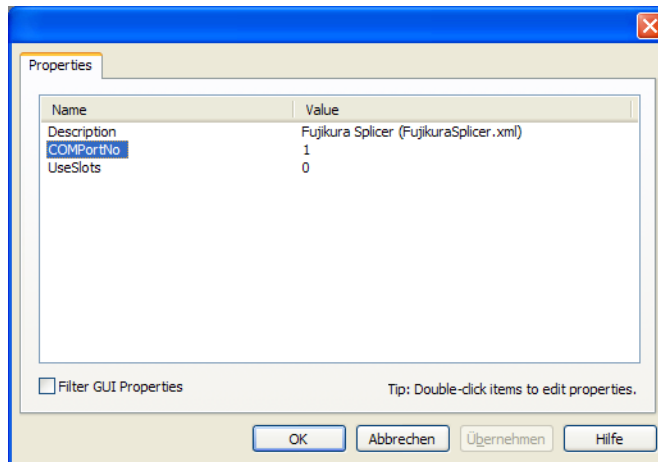
- Select "add" from the context menu of the *Misc. Instruments* node:



- Add the splicer manually:



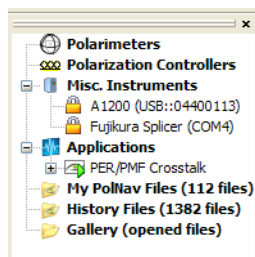
- If you are using a COM port other than COM1, go to the properties menu of the splicer and enter the appropriate COM-Port by double-clicking on the *COMPortNo*-entry:



- To check if the communication with the splicer is working, you can double-click on the splicer entry. You will see a panel allowing you to remote control the splicer keys:



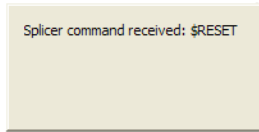
- Now connect a laser source to the first pigtail and the other pigtail to the A1200 input. Prepare the fibers and put them into the clamps of the splicer. Then start the application. If the application recognizes the splicer, it should be marked with a lock symbol:



- To see if the splicer can communicate with the application, press



the RESET button on the splicer. A small window should appear confirming the reception of the command:



- Now modify a PM splice program and select *R-A1200* as theta-aligning method. If you start the splice operation now, the splicer uses the Splice-Angle readout of the polarizationNAVIGATOR™.
- You can select the desired angle accuracy from the properties menu.
- If you are using an internal laser source, you can let the software automatically turn off the laser source when not in use. This can reduce effects caused by scattered light seen by the splicer camera. If you want to use that mode, set the parameter *LightSourceAutoOff* in the properties menu to "Yes".

## 6.5 Application: Polarimeter Calibration

Use this application to calibrate the polarimeter at a wavelength not included in the factory calibration range.

NOTE: You may have to add this application manually to the application tree by right-clicking on "Applications" and then selecting "Add". Choose "adaptif PHOTONICS Polarimeter Calibration" from the selection box.

The calibration is done in the following steps:

- Enter the wavelength you want to use into the dialog box.
- Connect the light source you are using to the polarimeter input. For the calibration process, it is recommended to also insert a polarization controller (e.g. peddles).  
NOTE: The light source should be fully polarized (DOP=1). Therefore, an unpolarized broadband source should be filtered by an in-line polarizer.
- Turn on the light source and start the application "Polarimeter Calibration".
- Click on "Run" and move the blue spot on the Poincaré sphere into the red marked regions. When passing one region, it will turn to green.
- After all regions have been passed by the blue spot, the calibration data is generated. You can assign a name to this calibration set.

After running this application, the polarimeter automatically uses the calibration set. You can leave the application now by clicking on "Exit" and use the polarimeter by double-clicking on the instrument.

### 6.5.1 Selecting Former Calibration Data

NOTE: After restarting the software, the factory calibration data is selected.

You can select the desired calibration data set by right-clicking on the polarimeter (you may have to click on the "Objects" button in the toolbar to show the object browser) and clicking on "Properties".

Go to the tab "Calibration" and select the appropriate calibration data set.

## 6.6 Application: Continuous Scrambling

Use this application to scramble the polarization state using an A3xxx instrument or an A2000.

The LiNbO<sub>3</sub> waveplates are controlled in a way that creates a continuous movement of the output polarization state.

After activating this application, you can start and stop the scrambling process. The parameter scanrate defines the scrambling speed. An estimation of the resulting scrambling speed is given in the status field.

The scanrate settings 1-8 correspond approximately to the scanrate settings of the Agilent 11896 polarization controller.

See also *Automation: Continuous Scrambling* (section 11.11)

## 6.7 Using Multiple Laser Sources

It is supported by the software to connect several laser sources to the GPIB port of the computer or the instrument (configure these laser sources to different GPIB addresses). However, the applications can only control one laser source at a time. Therefore, you can add the same application twice to the browser window and associate the two applications with two laser sources.

Use, for example, the following steps to configure the *PDL/PMD-Application* (section 6.2) for two laser sources:

- Run the wizard to perform the automatic configuration. Your two laser sources should be listed under *Misc.Instruments*.
- Double-click on the *PDL/PMD-Application* (section 6.2) . You will be asked for the laser source you want to use together with this application. This configuration will also be used for the next time you start the application.
- Exit the application.
- Rename the application by right-clicking and selecting *Rename* or by clicking on the entry once again. Choose a name describing the laser source (e.g. "C-Band")
- Add the same application again by right-clicking in the browser window and choosing *Add*. Choose *adaptif PHOTONICS Swept PDL/PMD Test*.
- Double-click on the new application and choose the other laser source.
- Exit the application.
- Rename the application.

Note: Once the link to an instrument is stored, it can only be changed by deleting the application and re-adding it again.

### 6.7.1 Trigger Configuration

If you are using two or more laser sources, the trigger outputs of these laser sources have to be tied together and fed to the trigger input port of the instrument.

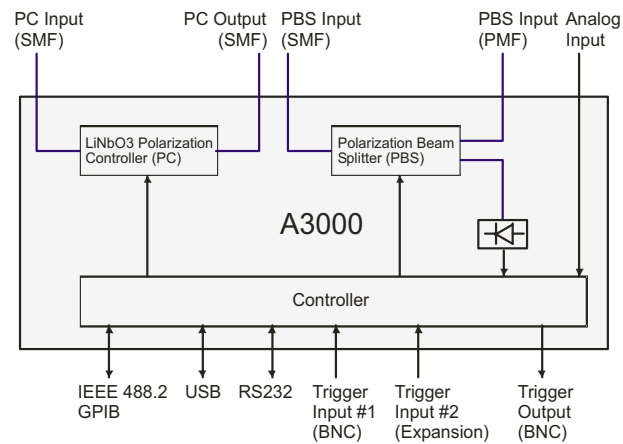
If you are using the *PDL/PMD-Application* (section 6.2) together with Agilent Tunable Laser sources, this can be done by daisy-chaining the trigger signals:

- Connect the *trigger output* of laser 1 to the *trigger input* of the laser 2.
- Connect the *trigger output* of laser 2 to the *trigger input* of the adaptif-instrument.

The software will configure the trigger settings of these sources to *PASSTHROUGH*.

## 7 Hardware

### 7.1 A3000 Block Diagram



### 7.2 Connector Pinouts

#### 7.2.1 Pinout RS 232 Connector

Pin	Function
1	
2	TxD
3	RxD
4	
5	GND
6	
7	CTS
8	RTS
9	

#### 7.2.2 Pinout Expansion Connector

Pin	Function
1	Analog Out A
2	Analog Out C
3	GND
4	Trigger Input #1
5	Trigger Input #2
6	
7	
8	Analog In GND
9	Analog Out B
10	Analog Out D
11	GND
12	Trigger Out
13	Analog In
14	
15	

### 7.3 Electrical Data

#### 7.3.1 Power Supply

Voltage:	12V.. 18V unregulated
Current:	2A (peak)
Power Consumption:	36W (peak)

#### 7.3.2 Digital Inputs

Technology:	AC series (advanced high-speed CMOS)
Input Voltage Range:	0V.. 5V
Digital Input Levels:	1,65V .. 2,75V (low level) 2,75V .. 3,85V (high level)

#### 7.3.3 Digital Outputs

Technology:	AC series (advanced high-speed CMOS)
Digital Output Levels:	0,36V .. 0,44V (low level) 4,76V .. 4,86V (high level)

#### 7.3.4 RS232 Signals

Input Voltage Range:	-12V..12V
Output Voltage:	+/- 5V

## 8 LabView™ Drivers

Installation The LabView™ driver libraries are installed upon installation of the polarizationNAVIGATOR™. You can find them in the applications program directory:

`c:/Programme/Adaptif Photonics GmbH/Polarization Navigator/`

or

`c:/Program Files/Adaptif Photonics GmbH/Polarization Navigator/`

The LabView™ driver libraries contain the following files:

MIP.llb	Collection of VIs for LabView VISA initialization and low-level communication
MIPCommands.llb	Collection of VIs for device programming on application level
Changed.llb	Miscellaneous VIs used in <code>DemoPolarimeter.vi</code>
PoincareSphere.llb	Miscellaneous VIs for graphical Poincaré sphere display

### 8.1 Starting a VISA Session

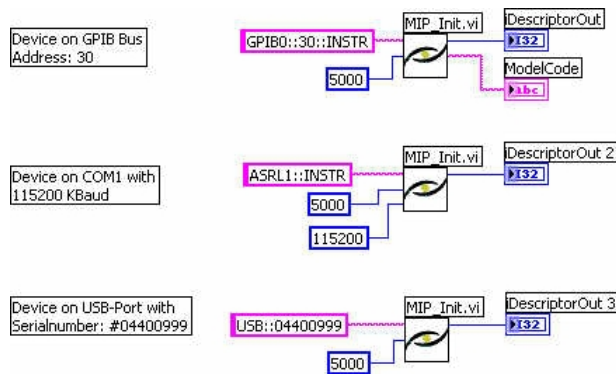
To initialize a new VISA session to any of Adaptif's Axxx devices from your LabView™ VI, start with the VI `MIP_Init.vi` which can be found in library `MIP.llb`.

The VI initializes the communication between your VI and the device over the desired interface port and assigns the device a unique device descriptor number which can be used throughout the whole LabView session to address that particularly device. To choose the correct interface for communication the VI is handed over the VISA resource name (or VISA alias) for the desired port, used in National Instruments "Measurement & Automation Explorer" (for further information please refer to the NI-VISATM Programmer Reference Manual). When using an USB interface for communication the VISA resource name consists of the prefix string "USB:" followed by the serial number of the device. If the PC controlling the instrument is equipped with an Ethernet adapter, the instrument can be accessed remotely by using an additional TCP prefix, containing the IP address of the PC, followed by the GPIB or USB string, which is used on the PC the instrument is connected to, e.g. "TCP::192.168.0.1::USB::04400001". Instruments of the Axxxx-B3/R3 series are equipped with an internal PC, internal USB communication and an ethernet adapter, so if such an instrument is connected to the local area network or the internet and its IP address is known, it can be accessed from LabView-VIs running on a remote PC by using a descriptor like "TCP::192.168.0.1::USB::04400001", where the IP address and the serial number have to be changed to the actual instrument.

Two additional parameters can optionally be handed over to the VI, which are the device timeout settings in ms (not mandatory) and the device communication baud rate when used with a serial interface.

The VI returns the device descriptor number as stated above and the model identification code for the device found on that interface address.

An example for a VISA session setup is shown below (here: timeout is set to 5000ms):



## 8.2 Variable Handling

All variables available for communication on the device are arranged in a tree structure and are addressed by their tree/branch (TreeNo) and variable number (VarNo). Additionally each variable has a type from the following list:

Binary, UINT8, UINT16, UINT32, INT8, INT16, INT32, TEXTSTRING, ARRAYUINT8, ARRAYUINT16, ARRAYUINT32, ARRAYINT8, ARRAYINT16, ARRAYINT32, ARRAYTEXTSTRING, FLOAT32, ARRAYFLOAT32

All variables and trees available on the devices are listed in the appendix (see *Variable Reference* (section 10) ). When using variables with an (1D) array type, you can address each sub element by its index number (Index).

## 8.3 Error Codes

All VIs return an error code after execution which shows the result of the latest operation. If no error has occurred the VI should return zero, otherwise you can find the corresponding explanation in the error list in the appendix (see *Error Codes* (section 15.3) ).

## 8.4 Generic Instrument Settings VIs

All VIs described here can be found in the library `MIPCommands.11b` and are used to get or set any device specific variables. The device you want to communicate with is addressed by the device descriptor number as described above (see *Starting a VISA Session* (section 8.1) ).

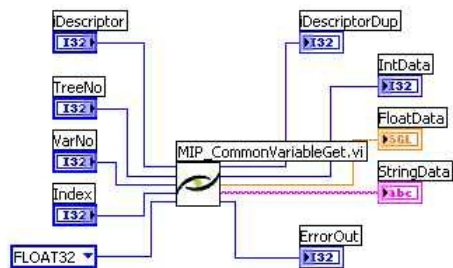
Not all listed input and output parameters are mandatory or valid for operations on different variable types. The parameters which are optional or only valid for only one type of variables are indicated with square brackets in the following list.

### 8.4.1 MIP\_CommonVariableGet

To get the value of a variable available on your device, you can use the VI `MIP_CommonVariableGet.vi`. You specify the descriptor numbers and type for the requested variable and receive its current value in the matching output field.

Please note that array type variables can only be accessed through their single elements using the index parameter.

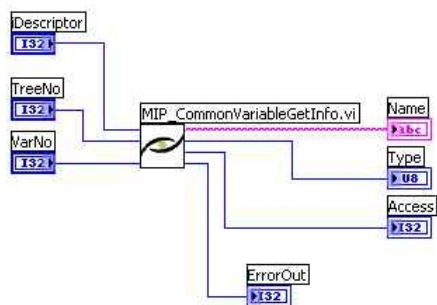
Input parameters:	Device descriptor, tree number, variable number, index number, variable type
Output parameters:	Device descriptor, (integer data, float data, string data), error code



#### 8.4.2 MIP\_CommonVariableGetInfo

Use the VI `MIP_CommonVariableGetInfo` to get information about a specific variable. The VI returns the name (as plain text) of the specified variable plus its type and access mode.

Input parameters:	Device descriptor, tree number, variable number
Output parameters:	Variable name, variable type, variable access

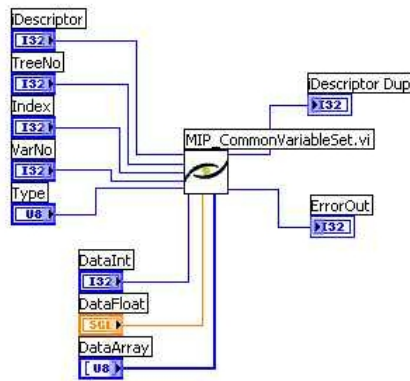


#### 8.4.3 MIP\_CommonVariableSet

To set the value of any accessible variable on your device use the VI `MIP_CommonVariableSet`. The usage is very similar to reading variables from the device (see *MIP\_CommonVariableGet* (section 8.4.1) ).

Input parameters:	Device descriptor, tree number, variable number, (index number), variable type, (DataInt, DataFloat, DataArray)
Output parameters:	Device descriptor, error code





## 8.5 Polarization Controller VIs

The following VIs can be used to control the polarization controller (applicable to A2xxx and A3xxx) in your application, i.e. to set all important control parameters and to start and stop the different scrambling modes.

### 8.5.1 MIP\_PolConSettings

This is the central VI to control the different modes of the polarization controller. All necessary parameters to start the polarization controller can be specified according to the following list:

Input parameters:	Device descriptor, scrambling mode, timebase, synchronization, sequence starttrigger, repetition rate, divider, holdoff delay, sequence length
Output parameters:	Device descriptor, error code

#### scrambling mode

- Off (turns off all scrambling modes)
- Random (scrambling with a pseudo random sequence)
- Sequence (scrambling with user definable sequence)

#### timebase

- Internal Timer (uses polarization controller timer)
- Polarimeter Clock (uses polarimeter timer for synchronization purpose, only valid on A2000 and A3300)
- External Trig-In (uses external trigger input #1)

#### synchronization

- Auto Repeat (scrambling sequence is processed repeatedly)
- OneShot (scrambling sequence is processed just once. The polarization controller remains on the last table entry)

#### sequence starttrigger

- Auto (scrambling sequence is untriggered and started by software)

- External (scrambling sequence is (re-)started by external event. The input port is dependent on timebase settings, i.e. for internal timers trigger input #1 is used and for external timebase trigger input #2 on expansion port is used)
- Polarimeter (scrambling sequence is (re-)started with every polarimeter measurement start)

**repetition rate**

- Scrambling rate in kHz (only applicable to internal timer as timebase)

**prescaler**

- Additional prescaler m for timebase (default: m=0); the resulting scrambling rate is: repetition rate / (m+1), (i.e. m=0 means no prescaling, m=1 means half repetition rate, etc.)

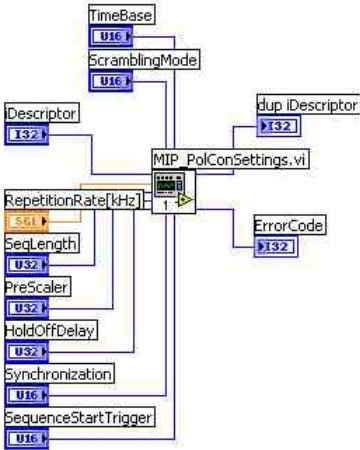
**holdoff delay**

- time of sequence restart relative to the external trigger signal in  $\mu s$ ; only applicable to external trigger events.

**sequence length**

- Scrambler sequence length; applicable to pseudo random sequence. When using user-definable scrambling sequence, length is determined by sequence length in memory.

NOTE: This VI replaces MIP\_PolConStart.vi, which was used in previous revisions.



8.5.2 MIP\_PolConSetMode

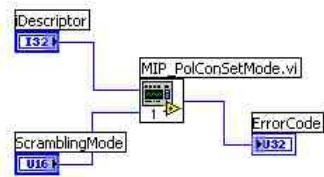
This VI starts the polarization controller with is the specified mode using the current settings from the device variables.

Input parameters:	Device descriptor, scrambling mode
Output parameters:	Error code

**scrambling mode**

- Off (turns off all scrambling modes)

- Random (scrambling with a pseudo random sequence)
- Sequence (scrambling with user definable sequence)



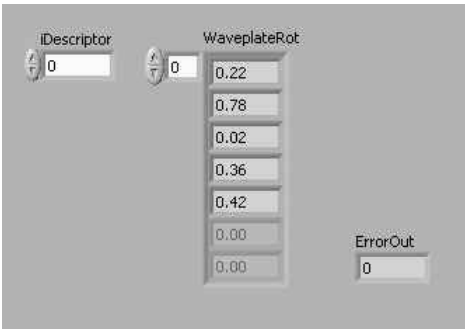
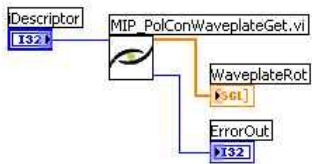
### 8.5.3 MIP\_PolConWaveplateGet

This VI is used to get the current rotation angles of all 5 virtual wave plates of the LiNbO<sub>3</sub> polarization controller (see *A3XXX Polarization Controller Operation* (section 5.2) ).

Input parameters:	Device descriptor
Output parameters:	Wave plate positions (1D), error code

#### WaveplateRot

- Current positions of the wave plates returned as 1-dimensional array, consisting of 5 values representing the rotation angle of each wave plate in radians.



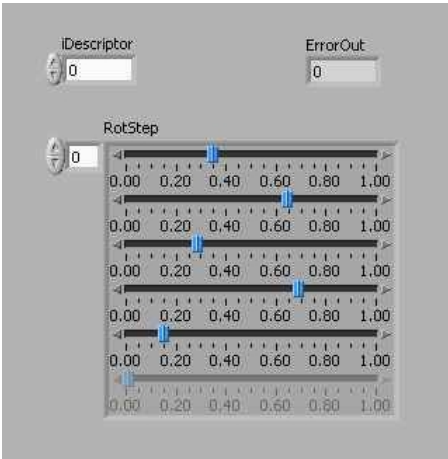
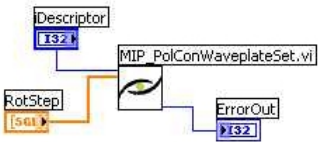
### 8.5.4 MIP\_PolConWaveplateSet

This VI is used to manually set the rotation position of the 5 virtual wave plates of the LiNbO<sub>3</sub> polarization controller.

Input parameters:	Device descriptors, wave plate positions (1D)
Output parameters:	Error code

#### WaveplateRot

- 1D array of 5 elements representing the wave plate rotation angles (in radians  $0..2\pi$ ) of the polarization controller to be set. Larger values than  $2\pi$  for the rotation angle can be accepted, though they represent the same rotation angle, due to the internal structure of endlessly rotatable wave plates.



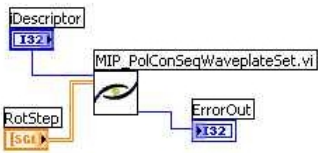
8.5.5 MIP\_PolConSeqWaveplateSet

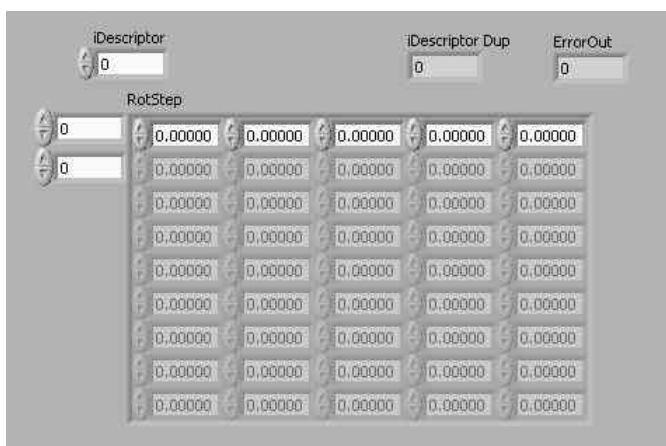
This VI is used to program a sequence of wave plate rotation settings into the polarization controller, which can then be used as sequence source in *sequence* mode (see `MIP_PolConStart`).

Input parameters:	Device descriptor, wave plate positions sequence (2D)
Output parameters:	Error code

RotStep

- 2D table consisting of n rows (n= length of sequence steps), each representing one wave plate rotation setting (similar to 1D-” *WaveplateRot* in `MIP_PolConWaveplateSet`).





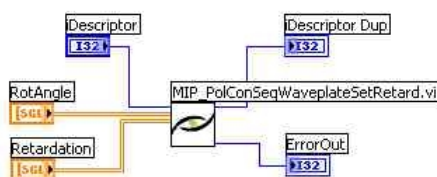
### 8.5.6 MIP\_PolConSeqWaveplateSetRetard

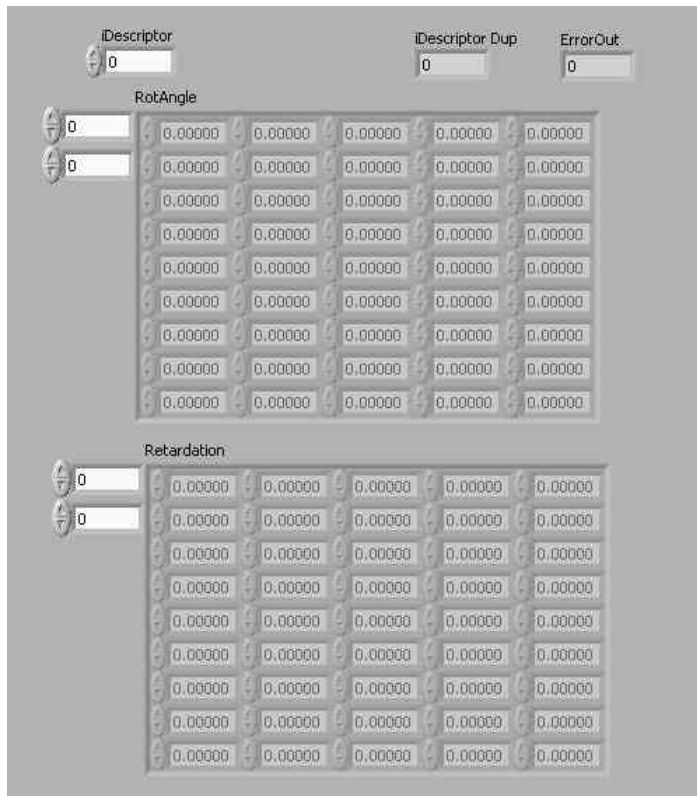
This VI is used to program a sequence of wave plate rotation settings into the polarization controller, which can then be used as sequence source in *sequence* mode (see MIP\_PolConStart).

Input parameters:	Device descriptor, wave plate positions sequence (2D)
Output parameters:	Error code

#### RotStep

- 2D table consisting of n rows (n= length of sequence steps), each representing one wave plate rotation setting (similar to 1D-WaveplateRot in MIP\_PolConWaveplateSet).





## 8.6 Polarimeter Control VIs

The following VIs are used to control and readout the polarimeter (applicable to A1xxx and A2xxx). For a complete polarimeter demo application see *Demo VIs* (section 8.7.2) .

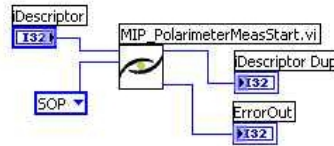
### 8.6.1 MIP\_PolarimeterMeasStart

This VI is used to start a new polarimeter measurement. The measurement parameters (e.g. sampling rate, number of samples, etc.) used for the data acquisition are stored in the variable tree structure and can be changed prior using the VI `MIP_CommonVariableSet`.

Input parameters:	Device descriptor, measurement mode
Output parameters:	Device descriptor, Error code

#### Measurement mode

- IDLE (currently running measurement is stopped)
- SOP (measurement results are returned as 4-element Stokes parameters)
- SOPCONTINUOUS (time-continuous measurement is started; please ensure to pick up all results in appropriate time intervals to prevent data loss due to internal ring buffer structure)



## 8.6.2 MIP\_PolarimeterMeasState

This VI is used to get information about the current measurement state of the device.

Input parameters:	Device descriptor
Output parameters:	Device descriptor, number of samples, trigger state, measure state

### nSamples

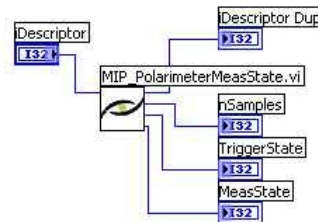
- Number of samples available

### TriggerState

- IDLE (no measurement)
- ARMED (measurement initialized, waiting for trigger)
- SAMPLING (measurement in progress)
- DATAAVAILABLE (measurement completed)
- ERROR (error occurred)

### MeasState

- Measurement error code (see *Error Codes* (section 15.3) )



## 8.6.3 MIP\_PolarimeterMeasStartGet

This VI starts a measurement and waits for completion. Measurement parameter are stored in the variable tree structure prior to starting this VI. The results of the measurement are returned either in a floating-point or integer array, depending on the measurement mode. Currently only floating-point data will be returned when measuring SOPs.

Input parameters:	Device descriptor, measurement mode
Output parameters:	Device descriptor, float results, short results, number of samples, rows, error code

### Measurement mode

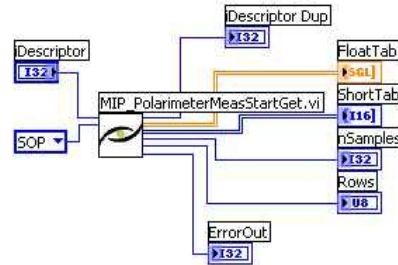
- See *MIP\_PolarimeterMeasStart* (section 8.6.1) .

### FloatTab/ShortTab

- Results of previous measurement according to selected measurement mode.

#### nSamples

- Number of samples available. Rows Number of valid rows (depends on measurement mode)



### 8.6.4 MIP\_PolarimeterMeasGet

This VI is used to retrieve data available on the device.

Input parameters:	Device descriptor, measurement mode, fraction start, fraction length
Output parameters:	Device descriptor, float results, short results, number of samples, rows, error code

#### Measurement mode

- See *MIP\_PolarimeterMeasStart* (section 8.6.1) .

#### FractionStart

- Startindex in results for fraction data transfer (for no fraction transfer use default: -1).

#### FractionLength

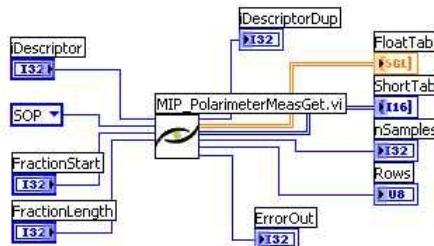
- Length of fraction.

#### FloatTab/ShortTab

- Results of previous measurement according to selected measurement mode.

#### nSamples

- Number of samples available. Rows Number of valid rows (depends on measurement mode)





8.6.5 MIP\_PolarimeterMeasPlot

This VI can be used as standalone VI to start a measurement and display the results in a graph. All important parameters can be set prior to the measurement using the defined control elements. Changes in the control elements are valid only after restarting the VI.

Input parameters (control elements):	VISA descriptor, Baudrate, measurement mode, trigger source, sampling rate, number of samples, wavelength, sweeprate, gain
Output parameters (display on screen):	Results plot, error code

TriggerSource

- NONE (starts immediately; software trigger)
- TTL HIGH (low-to-high transition on external trigger-in starts measurement)
- TTL LOW (high-to-low transition on external trigger-in starts measurement)

SamplingRate

- Sampling rate in kHz

Wavelength

- Lightsource wavelength in nm

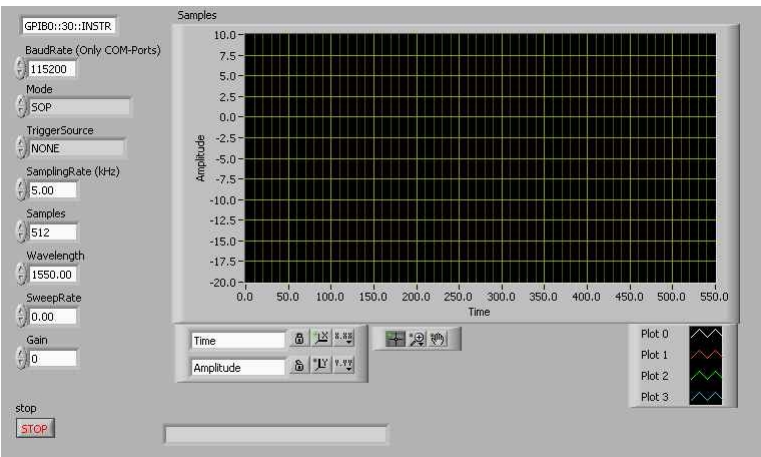
SweepRate

- Lightsource wavelength sweeprate in nm/s

NOTE: for fixed wavelength source set to 0 nm/s

Gain

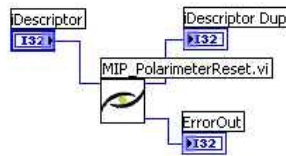
- Amplifier gain (0-13)



8.6.6 MIP\_PolarimeterReset

This VI is used to reset the polarimeter into its initial state. All measurement parameters are set to their values after device power-up.

Input parameters:	Device descriptor
Output parameters:	Device descriptor, error code

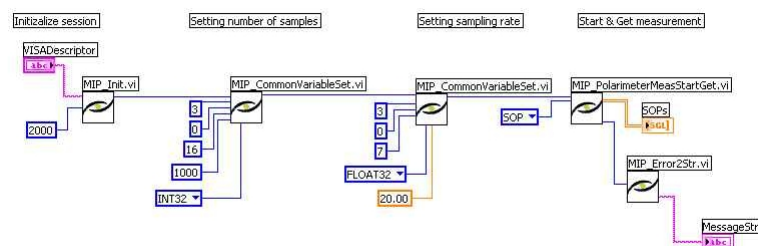


## 8.7 Demo VIs

### 8.7.1 DemoPolarimeterSimple

This VI demonstrates the basic usage of the interface VIs. It first opens a session to the instrument connected via GPIB, address 30. Then the desired number of samples is set to 1000 and the sampling rate is chosen to be 20 kHz.

Note that the VI *MIP\_PolarimeterMeasStartGet.vi* (section 8.6.3) waits until a measurement has been successfully completed, i.e. it waits until the polarimeter receives a suitable power level.



### 8.7.2 PolarimeterDemo

This VI demonstrates a complete polarimeter measurement application. You must specify the desired VISA communication port (use GPIB0::30::INSTR for an instrument at GPIB address 30). The measurement parameters can be changed during runtime and include the following parameters:

#### Tab Polarimeter

- AutoGainFlag, TriggerSource, Samples, SamplingRate, Gain(manual)

#### Tab Source

- Wavelength(fixed or startwavelength if swept), Sweeprate(in nm/s, 0 for fixed wavelength)

The results of the measurement are displayed in different diagrams:

#### Tab Polarimeter

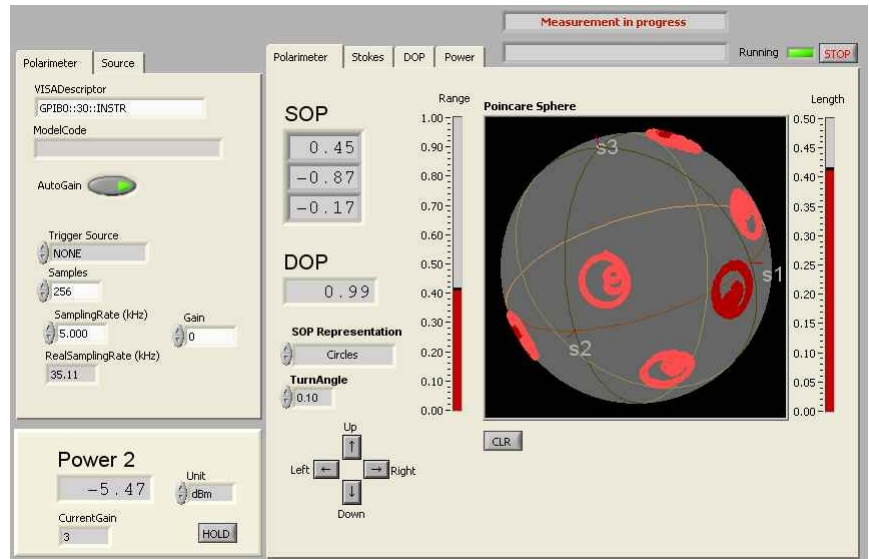
- SOP displayed on Poincaré sphere. Use cursor array in VI to rotate sphere.

#### Tab Stokes

- Stokes parameters displayed in graph

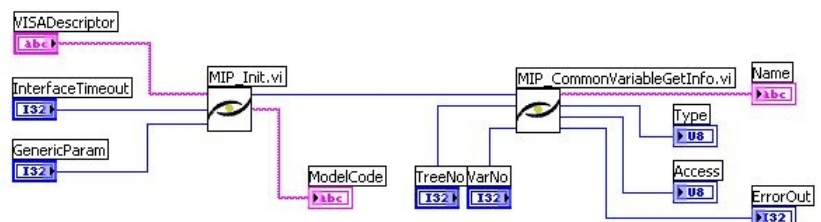
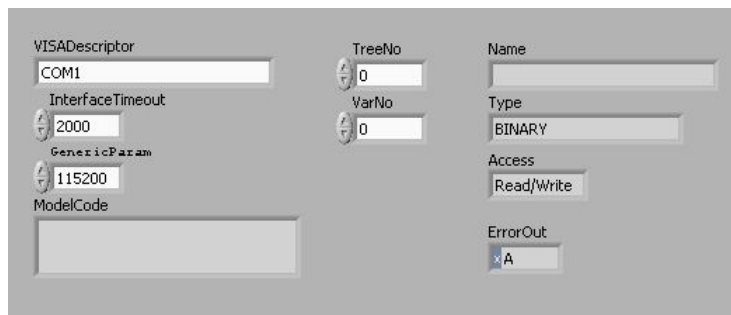
## Tab DOP

- DOP displayed in graph Tab Power Power display in graph



### 8.7.3 DemoVarInfo

This VI starts a VISA session with a device (here: at port COM1 with 115200 kBAud) and receives its model code. Afterwards the VI reads the variable information from the specified tree and variable number and shows the results in the appropriate fields.



## 9 GPIB/RS232 Command Reference

This chapter summarizes all available (ASCII-) commands with their syntax and parameter lists. ASCII commands can be used for device com-

munication over the GPIB or RS232 interface. Every command starts with an asterisk (\*) and returns an *errorcode* (section 15.3) from the device. If a command or result has more than one parameter handed over, each parameter is separated by a comma (,). Note that floating point values use a . as decimal point.

NOTE: When using the USB port for device communication the ASCII commands are not applicable. In this case please use the LabView™ VIs provided in the driver libraries instead (see *LabView Drivers* (section 8)).

## 9.1 Generic control commands

These commands are used to get device specific information and access device variables.

Explanation:

TreeName	Name of <i>variable tree</i> (section 10) as plain text
TreeNo	Number of <i>variable tree</i> (section 10) as integer
VarName	Name of <i>variable</i> (section 10) as plain text
VarNo	Number of <i>variable</i> (section 10) as integer
Index	Variable index in arraytype [0..max]

### 9.1.1 \*IDN?

Get device identification

Syntax: \*IDN?  
Results: \*{ErrorCode},{IDString}

### 9.1.2 \*VAR?

Get device variable value

Syntax: \*VAR? {TreeName},{VarName}  
\*VAR? {TreeNo},{VarNo}  
\*VAR? {TreeName},{VarName},{Index}  
\*VAR? {TreeNo},{VarNo},{Index}  
Results: \*{ErrorCode},{Value}

### 9.1.3 \*VARNAME?

Get device variable description

Syntax: \*VARNAME? {TreeName},{VarName}  
\*VARNAME? {TreeNo},{VarNo}  
Results: \*{ErrorCode},{VarType},{VarAccess},{VarTextName}

### 9.1.4 \*VAR

Set device variable value

Syntax: \*VAR {TreeName},{VarName},{Value}  
\*VAR {TreeName},{VarName},{Index},{Value}  
Results: \*{ErrorCode}

## 9.2 Buffer control commands

### 9.2.1 \*BUF?

Returns the current buffer size in bytes.

Syntax: **\*BUF?**

Results: **\*{ErrorCode},{buffersize}**

Parameters: **buffersize(int)** Buffer size in bytes

### 9.2.2 \*BUFR?

Returns the contents of the buffer as binary, hex or numeral values. The startindex and length of returned data can be specified by the fraction parameters.

NOTE: When using GPIB as communication interface the maximum transfer size per command is limited to approximately 800 bytes (i.e. 400 hex values). For transferring buffers of larger size you have to split the read out in successive buffer reads commands of appropriate transfer size.

NOTE: the startindex and length depends on the requested data type. For hex and binary dumps the indices refer to byte positions. For numeral outputs the indices refer to number positions.

NOTE: floating point numbers are returned in single precision format (IEEE 754)

Syntax: **\*BUFR?**

**\*BUFR? {HEX|NUM},{ALL}**

**\*BUFR? {HEX|NUM},{fractionstart},{fractionlength}**

Results: **\*{ErrorCode},{results}**

Parameters: **fractionstart(int)**

startindex of requested data block

**fractionlength(int)**

Length of requested data block

**results(in specified format)**

- HEX: hex dump
- NUM: int/float numbers

NOTE: hex dumps are returned in little endian format

### 9.2.3 \*BUFALLOC

Reserves space in memory for writing into buffer.

Syntax: **\*BUFALLOC {length}**

Results: **\*{ErrorCode}**

Parameters: **length(int)**

specifies the size of allocated memory and is interpreted as number of (float/int) elements in buffer

### 9.2.4 \*BUFW

Writes into allocated buffer memory

Syntax: **\*BUFW {offset},{value0[,value1,value2,...]}**

Results: **\*{ErrorCode}**

Parameters: **offset (int)**

Specifies the starting index for writing into the buffer. Larger values than actual buffer length returns an error

**value0..n (float)**

Are the values interpreted as floating point numbers, written in the buffer starting at specified offset address. Writing more value than buffer length returns an error.

## 9.3 Polarization Controller Commands

### 9.3.1 \*POLCON:START

Starts the polarization controller

Syntax: **\*POLCON:START {SCR|SEQ}**

Results: **\*{ErrorCode}**

Parameters: **SCR**

Starts pseudo-random scrambling

**SEQ**

Starts scrambling with defined sequence

### 9.3.2 \*POLCON:STOP

Stops the polarization controller

Syntax: **\*POLCON:STOP**

Results: **\*{ErrorCode}**

### 9.3.3 \*POLCON:WP?

Get current positions of polarization controller waveplate elements. Returned are the rotation angles for the controller elements in rad.

Syntax: **\*POLCON:WP?**

Results: **\*{ErrorCode},{angle0},{angle1},{angle2},{angle3},{angle4}**

Parameters: **angle(float)**

Rotation angle in rad

### 9.3.4 \*POLCON:WP

Set current positions of polarization controller waveplate elements.

Syntax: **\*POLCON:WP {angle0},{angle1},{angle2},{angle3},{angle4}**

Results: **\*{ErrorCode}**

Parameters: **angle(float)**  
Rotation angle in rad

### 9.3.5 \*POLCON:SEQSET

Sets a new programmable scrambling sequence based on the values written previously into the buffer memory. To set up the values for a new sequence, write the rotation angle values for each waveplate into the buffer memory using the commands *BUFALLOC* and *BUFW*. The number of sequence elements must be a multiple of the number of control elements (*nPolConRot*) of the polarization controller otherwise an error is returned.

Syntax: **\*POLCON:SEQSET**  
Results: **\*{ErrorCode}**

## 9.4 Polarimeter control commands

### 9.4.1 \*POLMET:RESET

Resets the polarimeter and sets all measurement parameters to their default values.

Syntax: **\*POLMET:RESET**  
Results: **\*{ErrorCode}**

### 9.4.2 \*POLMET:START

Starts a new polarimeter acquisition using the current measurement parameters. The measurement type is determined by the indicated mode parameter

Syntax: **\*POLMET:START SOP**  
Results: **\*{ErrorCode}**

### 9.4.3 \*POLMET:STATE?

Returns the current polarimeter acquisition status, including number of samples taken, trigger state and polarimeter errorcode.

Syntax: **\*POLMET:STATE?**  
Results: **\*{ErrorCode},{data sampled},{trigger state}, {polarimeter errorcode}**

Parameters: **data sampled(int)**

Number of samples taken so far

**trigger state(int)**

Current polarimeter trigger status (see variable *TriggerState* (section 10.2) )

**polarimeter errorcode(int)**

Current polarimeter error status (see *Error Codes* (section 15.3) for explanation)

#### 9.4.4 \*POLMET:SOP?

Returns the current SOP from the polarimeter as single Stokes vector.

Syntax: **\*POLMET:SOP?**

Results: **\*{ErrorCode},{s0},{s1},{s2},{s3}**

Parameters: **s0..3(float)**

Stokes parameters

#### 9.4.5 \*POLMET:NSOP?

Returns the current SOP from the polarimeter as DOP and single normalized Stokes vector.

Syntax: **\*POLMET:NSOP?**

Results: **\*{ErrorCode},{DOP},{s0},{s1},{s2}**

Parameters: **DOP(float)**

Degree of polarization

**s0..3(float)**

Normalized Stokes parameters

#### 9.4.6 \*POLMET:GET?

Reads out the data from the current data acquisition and saves the results in the buffer. Note that successive calls of this command without restarting the measurement will return a measurement sequence error. To receive the results see (buffer control commands).

Syntax: **\*POLMET:GET?**

Results: **\*{ErrorCode},{buffersize}**

Parameters: **buffersize(int)**

Buffer size after read-out in bytes



### 9.5.1 Polarimeter Measurements

*BUFR? NUM,0,32	Readout measurement from buffer
<i>first 32 float values, corresponding to 8 Stokes vectors</i>	

```

Result: *0
0.062 0.021 -0.050 0.027
0.062 0.021 -0.050 0.027
0.063 0.021 -0.051 0.027
0.062 0.021 -0.050 0.027
0.062 0.021 -0.050 0.027
0.062 0.021 -0.050 0.027
0.062 0.021 -0.050 0.027
0.062 0.021 -0.050 0.027
0.062 0.021 -0.050 0.027

*BUFR? HEX,0,400                                Read buffer
Example for buffer readout with limited packet size Buffer size: 2048
bytes

Result: *0
D38AA43DFC0CF0BA98BEBABD146D683D
549E803DC0AC053D0DCE3FBD7069C33C
...

*BUFR? HEX,800,400                                Read remaining data
*BUFR? HEX,1200,400
*BUFR? HEX,1600,400
*BUFR? HEX,2000,48

```

## 9.5.2 Setting Up the Polarization Controller

This example shows how to set up the polarization controller to scramble with a pseudo random scrambling sequence of (sequence length: 1000 elements).

```

*VAR PolController,RepRate,10.0                Scrambling rate = 10kHz
Result: *0

*VAR PolController,Synchronization,0           Use autorepeat mode
Result: *0

*VAR PolController,TimeBase,0                  Use internal timer as timebase
Result: *0

*VAR PolController,PolConStartTrigger,0        Use software trigger
Result: *0

*VAR PolController,SeqLength,1000              Sequence length: 1000
Result: *0

*POLCON:START SCR                             Use pseudo random scrambling mode
Result: *0

```

This examples shows how to manually set the polarization controller position.

```

*POLCON:STOP                                  Stop polarization controller (all modes)
Result: *0

*POLCON:WP 0.1,0.4,-0.2,0.8,1.2               Set manually to a position
Result: *0

*POLCON:WP?                                  Get current polarization controller position

```

*Result: \*0,0.1,0.4,-0.2,0.8,1.2*

This example shows how to program a sequence of 2 entries (sequence length = 2 elements).

**\*VAR? PolController,nPolConRot**                      Get number of waveplates

*Result: \*0,5*

**\*BUFALLOC 10**    Allocate buffer

*2 sequence elements multiplied with 5 waveplates yields 10 floating point entries.*

*Result: \*0*

**\*BUFW 0,0.11,-0.22,0.33,-0.44,0.55**                      Write first sequence step

*Result: \*0*

**\*BUFW 5,-0.66,0.77,-0.88,0.99,-1.00**                      Write 2nd step

*Result: \*0*

**\*POLCON:SEQSET**    Generate sequence from buffer contents

*Result: \*0*

**\*POLCON:START SEQ**    Use sequence mode

*Result: \*0*

## 10 Instrument Variables

In the following a list of variables is given which are supported by the instruments.

Each variable has a unique variable number and variable name which are used to address the corresponding variable. Additionally each variable has a type and access code.

Variable types:

Type	Description
INT	integer number
FLOAT	floating point number
ARRAYINT	1D-array of integer numbers
ARRAYFLOAT	1D-array of floating point numbers
TEXT	text string

Variable access codes:

R	read only access
W	write only access
R/W	read/write access

### 10.1 Tree 0: Common

The variable tree **Common** is available on all instruments.

No	Name	Type	Acc.	Def.	Description
0	GPIBAddress	INT	R/W	30	GPIB address (1..30), only valid after restart
6	RS232BaudRate	INT	R/W	115200	valid values: 9600, 14400, 19200, 38400, 57600, 115200
7	RS232Echo	INT	R/W	1	turns Echo on(1)/off(0)
8	RS232HandShake	INT	R/W	0	turns hardware handshake (RTS/CTS) on(1)/off(0)
9	ModelCode	TEXT	R/W		instrument model code
10	SerialCode1	TEXT	R		instrument serial number
11	SerialCode2	TEXT	R		add. instrument serial number
12	SerialCode3	TEXT	R		add. instrument serial number
13	SerialCode4	TEXT	R		add. instrument serial number
17	SelfTestResult	INT	R	0	Result of selftest. 0=Selftest successful. Other values indicate a hardware damage.

### 10.2 Tree 3: Polarimeter

The variable tree **Polarimeter** is available on all A1xxx and A2xxx instruments.

No	Name	Type	Acc.	Def.	Description
1	WavelengthStart	FLOAT	R/W	1550.0	Wavelength in nm. In sweep mode: start wavelength in nm
2	SweepRate	FLOAT	R/W	0.00	Sweep rate in nm/s. 0: Fixed wavelength mode.
3	TriggerSource	INT	R/W	0	Trigger source 0: none 1: software 2: TTL high 3: TTL low
7	SamplingRate	FLOAT	R/W	5.0	Samplingrate in kHz
14	AutoGainFlag	INT	R/W	1	Auto gain 0: disable 1: enable
15	SweepState	INT	R	0	Sweep status 0: idle 1: SOP acq. running 2: SOP continuous acq. running
16	Samples	INT	R/W	256	Desired number of samples for data acquisition.
17	Gain	INT	R/W	0	Current polarimeter gain. Valid gain settings: 0..13. Write into this variable to manually select the gain setting.
28	LastPeakRange	FLOAT	R		Last occurred peak range. A value between 0..1 indicates the maximum power level occurred in the last measurement. A value of 1 corresponds to the maximum detectable power level in the used gain setting. Note that values below 0.3 can reduce SOP accuracy
29	LastPeakPower	FLOAT	R		Last occurred peak power in mW. This value is the power level corresponding to the peak value of variable <b>LastPeakRange</b> .
30	TriggerState	INT	R		Trigger state: 0: idle 1: armed 2: sampling 3: data available 4: error

### 10.3 Tree 4: PolController

The variable tree `PolController` is available on all A2xxx and A3xxx instruments.

No	Name	Type	Acc.	Def.	Description
1	nPolConRot	INT	R	5	Number of wave plates of the polarization controller
1	RepRate	FLOAT	R/W	5.0	Repetition rate in kHz
1	ScramblingMode	INT	R/W	0	PolController mode 0: off 1: random scrambling 2: sequence scrambling
1	Synchronization	INT	R/W	0	Synchronization: 0: autorepeat 1: oneshot <b>autorepeat</b> will restarted the sequence when finished. <b>oneshot</b> will stop the sequence at the end.
1	TimeBase	INT	R/W	0	Timebase 0: timer 1: polarimeter clock 2: external (BNC Trig-In) <b>polarimeter clock</b> is only valid for A2xxx/A3300
1	SequenceStartTrigger	INT	R/W	0	0: auto 1: external 2: polarimeter <b>auto</b> will start the sequence immediately. <b>external</b> will start the sequence on an external event. <b>polarimeter</b> will start the sequence with every polarimeter measurement start (valid for A2000/A3300).
1	Prescaler	INT	R/W	0	prescaler for repetition rate 0: no prescaling 1: div by 2 etc.
1	HoldOffDelay	INT	R/W	100	Hold off delay in $\mu s$ after receiving a trigger.
1	SeqLength	INT	R/W	12	Length of sequence.

## 11 Polarization Navigator Automation

The polarizationNAVIGATOR™ can be remotely controlled by sending human-readable commands and receiving a response from the software.

There are virtual devices you can communicate with, so-called "Targets".

As an example, you can send the following command to the target **Global**:

**Get Version**

The response will look like:

**Version 2.53 (1315), Built on Feb 22 2006 16:14:01**

*Use PolNavClientTest.exe to  
test the automation  
interface.*

You can use the test program **PolNavClientTest.exe** (you can find it in the Start-Menu) to communicate with the polarizationNAVIGATOR™. Please note that the polarizationNAVIGATOR™ has to be started before you can communicate.

*Minimize the  
polarizationNAVIGATOR™  
to the system-tray.*

You can minimize the polarizationNAVIGATOR™ to the system-tray on the lower-right side of the desktop: Right-click on the task bar entry and select "Minimize To Tray". You can also move the polarizationNAVIGATOR™ to your **Autostart** folder. In that case, the polarizationNAVIGATOR™ will be started automatically when you login. If you select "Minimize to system-tray on startup" from the *Options* menu, the polarizationNAVIGATOR™ will be minimized automatically to the tray.

### 11.1 Polarization Navigator Automation: Command Line Tool

You can use the command line tool **PolNavSendCommand.exe** for sending commands to the polarizationNAVIGATOR™. During the installation process, this file is placed into the system directory, so you don't have to set a path to access it.

For example, start the polarizationNAVIGATOR™ and type the following command at the command line:

**polnavsendcommand Global "Get Version"**

The response will look like:

**Version 2.53 (1315), Built on Feb 22 2006 16:14:01**

You can print the result code on the command line using the standard variable **ERRORLEVEL**:

**echo %ERRORLEVEL%**

The communication is implemented using a DLL which can be called from any software which supports DLL calls such as LabView, MATLAB, Visual C++ or Visual Basic.

In the directory **Examples/PolNavSendCommand\_VisualC++7.0\_SourceCode** in the program folder, you can find the source code to the command line tool and see how the DLL-calls can be implemented.

## 11.2 DLL Interface

The communication with the polarizationNAVIGATOR™ is implemented using a DLL interface.

The name of the DLL is `PolNavClient.dll`. It is installed in the `WINDOWS/SYSTEM32` directory during the setup process.

There are two exported functions. The C function prototypes are as follows:

```
int __stdcall PolNav_SendCommand(const char *Target,
                                const char *Command, char *Response, int MaxLen,
                                int &ResponseLen);

int __stdcall PolNav_ReadResponse(int iStart, int iLength,
                                  char *Response, int MaxLen, int &ResponseLen);
```

Commands: `PolNav_SendCommand`  
This function sends a command to the Navigator and retrieves the response.

Variables:

Parameter	Description
<b>Target</b>	<i>Target Name</i> (section 11.3)
<b>Command</b>	The command string to be sent to the Navigator.
<b>Response</b>	Pointer to a buffer reserved for the response. The calling application has to allocate enough memory to receive the response. The response is a 0-terminated string.
<b>MaxLen</b>	The size of the allocated response buffer.
<b>ResponseLen</b>	Here, the total length of the response is returned. If the response does not fit into the allocated buffer, only the first part is copied into the response buffer. Use <code>PolNav_ReadResponse</code> to access smaller fractions of the response.
<b>Return Value</b>	The return value is an <i>Error Codes</i> (section 15.3). A "0" indicates successful operation.

Commands: `PolNav_ReadResponse`  
This function sends a command to the Navigator and retrieves the response.

This function accesses fractions of the last received response. Particularly in VBA, strings cannot be longer than 32767 characters. Thus you will have to access longer response strings using this function.

Variables:



Parameter	Description
<b>iStart</b>	Start index of the fraction.
<b>iLength</b>	Number of characters to be read from the total response. A value of "0" reads the total response. A value of "-1" reads from the beginning indicated by iStart to the next CR or LF. This is particularly useful to parse plot data returned by the "GetPlot Default" command.
<b>Response</b>	Pointer to a buffer reserved for the response. The calling application has to allocate enough memory to receive the response. The response is a 0-terminated string.
<b>MaxLen</b>	The size of the allocated response buffer.
<b>ResponseLen</b>	Here, the total length of the fraction is returned.
<b>Return Value</b>	The return value is an <i>Error Codes</i> (section 15.3) . A "0" indicates successful operation.

See also *MATLAB* (section 11.12) , *LabView* (section 11.13) , *Python* (section 11.14) , *Visual Basic for Applications (VBA)* (section 11.15) to learn more about the usage of these functions.

### 11.3 Polarization Navigator Automation: Target Names

The communication with the polarizationNAVIGATOR™ uses so-called *targets* which act as virtual instruments. When communicating with the polarizationNAVIGATOR™ you have to specify the *target name* of the instrument or application you want to control.

You can query the target name of the instrument/application you want to control by right-clicking in the browser window and choosing "Device Server Properties". The target names are generated automatically. For the component test application the target name can be for example **CompTest00000**. If you specify **CompTest\*** as target name, the first component test application in the tree will be used as communication partner.

The communication with the polarizationNAVIGATOR™ is implemented using a *DLL Interface* (section 11.2) . A command string is sent to the Navigator which returns a response string.

The following targets are supported:

Target Name	Application /Instrument
<i>Global</i> (section 11.5)	Global Variables
<i>CompTest*</i> (section 11.8)	Component Test (PDL/PMD)
<i>CompTestStepped*</i> (section 11.9)	Component Test(Stepped)
<i>PERTest*</i> (section 11.10)	PER Test
<i>Polarimeter*</i> (section 11.6)	Polarimeter
<i>PolCon*</i> (section 11.7)	PolController

See *Commands Applying to All Targets* (section 11.4) for common commands applying to all targets.

### 11.4 Commands Applying to All Targets

The following commands apply to all targets:

Commands: **Activate**  
Activates the Instrument/Application.

**DeActivate**

Deactivates the Instrument/Application.

**Get VarName**

Retrieves the content of a variable. See table below for available variables.

**Set VarName,Value**

Sets the value of a variable. See table below for available variables.

**Dir TargetName**

Returns the available target names. **Dir** without any parameter will return all available target names. **Dir PolCon\*** will return all target names beginning with **PolCon**.

**Echo XYZ**

Sends the characters "XYZ" as response. This is can be used to test the communication.

**TestData n**

Returns sample plot data for debugging purposes. The response is a string which is formatted like a spreadsheet consisting of rows and columns. Columns are separated by a ",". Rows are separated by a LF (ASCII code 10). The number of rows is defined by the parameter **n**.

## 11.5 Target Global

The target name **Global** will select global variables such as the version number of the polarizationNAVIGATOR™.

Variables:

VarName	R/W	Type	Description
Version	R	string	Retrieves the version string of the polarizationNAVIGATOR™
Snptitle	R/W	string	The title field which is included in the saved PBIN files.
Snpcoment	R/W	string	The comment which is included in the saved PBIN files.
Snpoperator	R/W	string	The name of the operator which is included in the saved PBIN files.

## 11.6 Target Polarimeter

The target name **Polarimeter\*** will select the first polarization analyzer from the browser tree.

The following commands are available:

Commands: **Continuous**

Activates the Continuous Oscilloscope mode. In this mode, the polarimeter will be retriggered after finishing a measurement.

**Oneshot**

Activates the Oneshot Oscilloscope mode. In this mode, the polarimeter will be triggered only once.

**Trace**

Activates the Trace mode. In this mode, the polarimeter samples with a sampling rate of 2.5 kHz. If the parameter **TraceSensitivity** is set to 0, every incoming data point will be used. If **TraceSensitivity** is set to a value greater than zero, only data points are stored if the SOP has been changed by more than the value indicated by **TraceSensitivity**. If

**TraceSensitivity** is set to 0.02, for example, a new data point is taken only if the SOP has changed by at least 0.02 rad.

**Stop**

Stops a measurement.

**StartLogging**

Enables data logging. In the Trace mode, an ASC-II file is opened and all incoming SOP data is streamed into this file. The columns are: S0, S1, S2, S3, DOP.

**StopLogging**

Disables data logging.

**GetPlot Default**

Returns the plot data of the last measurement. The response is a string which is formatted like a spreadsheet consisting of rows and columns. Columns are separated by a ",". Rows are separated by a LF (ASCII code 10). See *SOP Data in ASC-II file format* (section 15.4.1) for details on the meaning of each column.

Variables:

VarName	R/W	Type	Description
Mode	R	string	Returns the current acquisition mode: Stop, Continuous, Oneshot, Trace.
SamplingRate	R/W	double	The sampling rate in kHz
Wavelength	R/W	double	The (start-) wavelength in nm.
SweepRate	R/W	double	The sweep rate in nm/s.
TriggerSource	R/W	string	Defines the trigger source. <b>TTLLow</b> : Trigger on high-to-low edge on the digital input. <b>TTLHigh</b> : Trigger on low-to-high edge on the digital input. <b>TTLLow(Pre)</b> : Trigger on high-to-low edge on the digital input. Supports pre-trigger buffering. <b>TTLHigh(Pre)</b> : Trigger on low-to-high edge on the digital input. Supports pre-trigger buffering. <b>SOPChange</b> : Trigger on an SOP event. The sensitivity can be defined by <b>TrigSenseAngle</b> and <b>TrigSenseTime</b> .
PreTrigSamples	R/W	int	Number of pre-trigger samples.
PostTrigSamples	R/W	int	Number of post-trigger samples.
AutoGain	R/W	bool	Auto gaining on (1) or off (0).
Gain	R/W	int	Current gain setting. 0: lowest sensitivity. 13: highest sensitivity.
LoggingInterval	R/W	double	Defines the minimum time (in seconds) between two logging events. A value of 0 will disable the timer.
LoggingMax	R/W	int	Maximum number of logging events (0=infinite)
LoggingFilenameBody	R/W	string	Defines a string to be used for automatic filename generation. The filename will be generated by adding a number to this string. The data will be stored in "My Polarization-Navigator Files".
IsLogging	R	bool	Returns the current logging state. 0:Inactive, 1:Active.

VarName	R/W	Type	Description
TraceSensitivity	R/W	double	Defines the trace accuracy (in rad) if the polarimeter is in the Trace mode. A value of 0 will store every data point. Values greater than 0 will only store data if the SOP has moved by more than TraceSensitivity.
TrigSenseAngle	R/W	double	Configures the SOPChange trigger mode. An event is generated if the SOP has moved by more than TrigSenseAngle (in deg) within the time indicated by TrigSenseTime.
TrigSenseTime	R/W	double	Defines the time interval observed in SOPChange trigger mode. A value of 0 indicates that TrigSenseAngle is relative to the last event. I.e. An event is created if the SOP has moved by more than TrigSenseAngle compared to the last event (regardless of the time).

## 11.7 Target PolController

The target name PolCon\* will select the first polarization controller instrument from the browser tree.

The following commands are available:

- Commands:
- Manual**  
Activates Manual Mode of the Instrument
  - Scramble**  
Activates Scrambling Mode of the Instrument
  - Sequence**  
Activates Sequence Mode of the Instrument
  - Randomize**  
Loads a new random sequence in scrambling mode
  - Stabilize**  
Activates Stabilization Mode of the Instrument

Variables:

VarName	R/W	Type	Description
WPL	R/W	double[5]	Waveplate positions in rad (5 comma-separated values).
Timebase	R/W	int	Timebase used for polcontroller Valid values: 0,1,2; for details see <i>PolController Tree</i> (section 10.3)
RepetitionRate	R/W	double	Repetition rate in kHz used for polcontroller
Prescaler	R/W	int	Prescaler value used for polcontroller
HoldOff	R/W	int	HoldOff value in ms used for polcontroller
Synchronization	R/W	int	Synchronization value in ms used for polcontroller Valid values: 0..5; 0="Auto Repeat", 1="Auto Oneshot", 2="External Repeat", 3="External Oneshot", 4="Polarimeter Repeat", 5="Polarimeter Oneshot".
SeqLength	R/W	int	Length for random sequences. Only valid when in scrambling mode
Sequence	W	string	Filename (optional with path) for sequence data to load (only valid when in sequence mode).
DigitalOutput	W	int	Sets the Trigger-Out BNC port to logical 0 or 1.
Wavelength	R/W	double	Operation wavelength of the polarization controller.
Stabilize	R/W	int	Activates (1) or deactivates (0) the control loop (only in stabilize mode).
TargetSOP	W	double[3]	Sets the desired target SOP. The command accepts 3 comma-separated values corresponding to the 3 normalized Stokes parameters.
CurrentSOP	R	double[4]	Reads the current SOP. The result is given by 4 comma-separated values representing the current SOP (not normalized).
CurrentSOPN	R	double[3]	Reads the current SOP. The result is given by 3 comma-separated values representing the current SOP (normalized).
CurrentDOP	R	double	Reads the current DOP.

Example (pseudo code) for activating the stabilizer function (only A3300):

```
PolNav_SendCommand("PolCon*", "Activate")
PolNav_SendCommand("PolCon*", "Stabilize")
PolNav_SendCommand("PolCon*", "Set TargetSOP,1,0,0")
PolNav_SendCommand("PolCon*", "Set Stabilize,1")
PolNav_SendCommand("PolCon*", "Get CurrentSOPN")
```

Example (pseudo code) for setting the current waveplate positions:

```
PolNav_SendCommand("PolCon*", "Set WPL,0.1,0.2,0.3,0.4,0.5")
```

## 11.8 Target CompTest

The target name **CompTest\*** will select the component test application.

A simple pseudo program controlling the component test application could be as follows:

```
DECLARE STRING PROGRESS,PLOTDATA

PolNav_SendCommand("CompTest*", "Activate")
PolNav_SendCommand("CompTest*", "Set WavelengthStart,1540")
PolNav_SendCommand("CompTest*", "Set WavelengthStop,1550")
PolNav_SendCommand("CompTest*", "SingleMeasurement")
DO
    PROGRESS=PolNav_SendCommand("CompTest*", "Get Progress")
    WAIT
WHILE PROGRESS<>"2"
PLOTDATA=PolNav_SendCommand("CompTest*", "GetPlot Default")
```

The following commands are available:

Commands: **GetPlot Default**

Returns the plot data of the last measurement. The response is a string which is formatted like a spreadsheet consisting of rows and columns. Columns are separated by a ", ". Rows are separated by a LF (ASCII code 10). See *PDL/PMD Data in ASC-II file format* (section 15.4.2) for details on the meaning of each column.

**SingleMeasurement**

Starts a single measurement. This is similar to pressing the button "Single Measurement" in the application.

**RepeatMeasurement**

Starts a repeated measurement. This is similar to pressing the button "Repeat Measurement" in the application.

**StopMeasurement**

Stops a measurement. This is similar to pressing the button "Stop Measurement" in the application.

**TakeReference**

Starts a reference measurement. This is similar to pressing the button "Take Reference" in the application.

**StartLogging**

Enables data logging.

**StopLogging**

Disables data logging.

**Save Filename**

Saves the current measurement into a PBIN-File

**Export Filename**

Saves the current measurement into an ASCII-File

Variables:

<b>VarName</b>	<b>R/W</b>	<b>Type</b>	<b>Description</b>
<b>Progress</b>	R	int	This variable is set to 0 when a measurement is started. It is increased once when the measurement is in progress. And it is increase once when the data has been evaluated. Thus you can wait until this variable becomes 2 before retrieving the data using the <b>GetPlot Default</b> command. In repeat mode the variable is not reset to 0. Thus the next measurement will be available if the variable becomes 4.
<b>WavelengthStart</b>	R/W	double	Start wavelength in nm.
<b>WavelengthStop</b>	R/W	double	Stop wavelength in nm.
<b>AutoResolution</b>	R/W	int	Turns the automatic resolution on/off (1/0).
<b>Resolution</b>	R/W	double	Resolution in nm.



VarName	R/W	Type	Description
PowerResolution	R/W	double	Resolution of Power trace in nm. 0 = Default.
SweepRate	R/W	double	Sweep rate nm/s. Allowed values are 0.5, 5.0, 10.0, 20.0, 40.0, 80.0
TLSPower	R/W	double	TLS power in mW.
UseLambdaLog	R/W	bool	Lambda login on/off (1/0).
AutoGain	R/W	bool	Auto gaining on/off (1/0).
UseReference	R/W	bool	Use reference measurement on/off (1/0).
CurrentGain	R/W	int	Current gain setting. Allowed values are 0..13
DynamicRange	R/W	string	Configures the dynamic range for the measurement. Allowed values are low, med, high.
Properties	R	string	Dumps the properties which are attached to the last measurement.
LastEvalError	R/W	int	Result of last evaluation. See <i>Error Codes</i> (section 15.3) for possible values.
Busy	R	bool	Application busy (1) or not (0).
Active	R	bool	Application activated (1) or not (0).
PlotNum	R	int	Number of available plots.
UseLivePower	R/W	bool	Enable (1) or disable (0) measurement of Live power level (which is shown on the Poincaré-Tab).
LivePower	R	double	Live power level (which is shown on the Poincaré-Tab).
LiveDOP	R	double	Live DOP.
LiveSOP	R	double	Live SOP.
LiveWavelength	R/W	double	Writing this variable immediately sets the laser wavelength to the specified wavelength in nm.
UseInternalRef	R/W	bool	Internal optical reference path is used (Yes) or not (No). It is recommended to leave this value set to Yes.
KeepRawData	R/W	bool	Raw data are embedded in the PBIN files (Yes) or not (No). Embedding raw data enables offline post processing but increases file size.
DetectModehops	R/W	bool	Try to detect mode hops (Yes) or not (No). Some laser sources can detect mode hops during the continuous sweep.
InternalRefValidMinutes	R/W	double	This value defines the maximum lifetime of an internal reference measurement in minutes. A value of 0 (default) defines infinite lifetime. Use a value greater than 0 if the power of your laser source is slowly drifting.

## 11.9 Target CompTestStepped

The target name **CompTestStepped\*** will select the component test application.

A simple pseudo program controlling the component test application could be as follows:

```
DECLARE STRING PROGRESS,PLOTDATA

PolNav_SendCommand("CompTestStepped*","Activate")
PolNav_SendCommand("CompTestStepped*","Set WavelengthStart,1540")
PolNav_SendCommand("CompTestStepped*","Set WavelengthStop,1550")
PolNav_SendCommand("CompTestStepped*","Set WavelengthStep,0.1")
PolNav_SendCommand("CompTestStepped*","SingleMeasurement")
DO
    PROGRESS=PolNav_SendCommand("CompTestStepped*","Get Progress")
    WAIT
WHILE PROGRESS<>"2"
PLOTDATA=PolNav_SendCommand("CompTestStepped*","GetPlot Default")
```

The following commands are available:

Commands: **GetPlot Default**

Returns the plot data of the last measurement. The response is a string which is formatted like a spreadsheet consisting of rows and columns. Columns are separated by a ",". Rows are separated by a LF (ASCII code 10). See *PDL/PMD Data in ASC-II file format* (section 15.4.2) for details on the meaning of each column.

**SingleMeasurement**

Starts a single measurement. This is similar to pressing the button "Single Measurement" in the application.

**RepeatMeasurement**

Starts a repeated measurement. This is similar to pressing the button "Repeat Measurement" in the application.

**StopMeasurement**

Stops a measurement. This is similar to pressing the button "Stop Measurement" in the application.

**TakeReference**

Starts a reference measurement. This is similar to pressing the button "Take Reference" in the application.

**Save Filename**

Saves the current measurement into a PBIN-File

**Export Filename**

Saves the current measurement into an ASCII-File

Variables:

VarName	R/W	Type	Description
Progress	R	int	This variable is set to 0 when a measurement is started. It is increased once when the measurement is in progress. And it is increase once when the data has been evaluated. Thus you can wait until this variable becomes 2 before retrieving the data using the <b>GetPlot Default</b> command. In repeat mode the variable is not reset to 0. Thus the next measurement will be available if the variable becomes 4.
WavelengthStart	R/W	double	Start wavelength in nm.
WavelengthStop	R/W	double	Stop wavelength in nm.
WavelengthStep	R/W	double	Step size in nm.
AutoResolution	R/W	int	Turns the automatic resolution on/off (1/0).
Resolution	R/W	double	Resolution in nm.
PowerResolution	R/W	double	Resolution of Power trace in nm. 0 = Default.
TLSPower	R/W	double	TLS power in mW.
AutoGain	R/W	bool	Auto gaining on/off (1/0).
UseReference	R/W	bool	Use reference measurement on/off (1/0).
CurrentGain	R/W	int	Current gain setting. Allowed values are 0..13
Properties	R	string	Dumps the properties which are attached to the last measurement.
UseInternalRef	R/W	bool	Internal optical reference path is used (Yes) or not (No). It is recommended to leave this value set to Yes.
KeepRawData	R/W	bool	Raw data are embedded in the PBIN files (Yes) or not (No). Embedding raw data enables offline post processing but increases file size.
LastEvalError	R/W	int	Result of last evaluation. See <i>Error Codes</i> (section 15.3) for possible values.

### 11.10 Target PERTest

The target name **PERTest\*** will select the component test application.

A simple pseudo program controlling the component test application could be as follows:

```

DECLARE STRING PER

PolNav_SendCommand("PERTest*", "Activate")
PolNav_SendCommand("PERTest*", "Set Wavelength,1550")
PolNav_SendCommand("PERTest*", "Set Mode,2")
PolNav_SendCommand("PERTest*", "StartMeasurement")
WAIT 4000
PolNav_SendCommand("PERTest*", "SetPER")

```

```

DO
    PER=PolNav_SendCommand("PERTest*", "Get PERCurrent")
    PRINT "PER = ";PER;" dB"
WHILE FOREVER

```

The following commands are available:

Commands: **StartMeasurement**

Starts the measurement. This is similar to pressing the button "Start Measurement" in the application.

**StopMeasurement**

Stops a measurement. This is similar to pressing the button "Stop Measurement" in the application.

**ResetPER**

Resets the worst-case PER reading (in swept-wavelength-mode) or unfixes the reference PER (in fixed-wavelength mode). This is similar to pressing the button "Reset PER" in the application.

**SetPER**

Fixes the worst-case PER reading (in swept-wavelength-mode) or fixes the reference PER (in fixed-wavelength mode). This is similar to pressing the button "Set PER" in the application.

**GetPlot Default**

Returns the plot data of the last measurement. The response is a string which is formatted like a spreadsheet consisting of rows and columns. Columns are separated by a ",". Rows are separated by a LF (ASCII code 10). See *PDL/PMD Data in ASC-II file format* (section 15.4.2) for details on the meaning of each column.

**TempCycle**

Starts the heat/cool temperature cycle if a Thermal Cycling Unit is attached.

**TempHeat**

Sets the Thermal Cycling Unit into heating mode.

**TempCool**

Sets the Thermal Cycling Unit into cooling mode.

**TempOff**

Turns off the power (no heating, no cooling) of the Thermal Cycling Unit.

Variables:

VarName	R/W	Type	Description
Wavelength	R/W	double	Center wavelength in nm.
SweepRange	R/W	double	Sweep range in nm.
Mode	R/W	int	1=Swept-Wavelength-Mode, 0=Fixed-Wavelength-Mode
TLSPower	R/W	double	TLS power in mW.
AutoGain	R/W	bool	Auto gaining on/off (1/0).
CurrentGain	R/W	int	Current gain setting. Allowed values are 0..13
PERCurrent	R	double	Current PER value in dB.
PERRef	R	double	Current worst-case-PER (in swept-wavelength-mode) or reference-PER (in fixed-wavelength-mode) in dB.

## 11.11 Target ContScrambling

The target name **ContScrambling\*** will select the continuous scrambling application (see *Continuous Scrambling* (section 6.6) for more details).

A simple pseudo program starting the scrambler could be as follows:

```
DECLARE STRING MaxSpeed
PolNav_SendCommand("ContScrambling*", "Activate")
PolNav_SendCommand("ContScrambling*", "Set Scanrate,8")
PolNav_SendCommand("ContScrambling*", "Set Enable,1")
MaxSpeed=PolNav_SendCommand("ContScrambling*", "Get MaxSpeed")
```

Variables:

VarName	R/W	Type	Description
Enable	W	bool	Enables (1) or disables (0) the scrambling mode.
IsScrambling	R	bool	Returns the state of the scrambler: 0=Off, 1=Scrambling.
Scanrate	R/W	int	Defines the scrambling speed (1-1000).
MaxSpeed	R	double	Maximum expected SOP movement rate (in rad/s).

## 11.12 Using MATLAB

As described in the chapter *DLL Interface* (section 11.2) , the DLL **PolNavClient.dll** can be used to send commands to the polarization NAVIGATOR. Making use of this DLL is very simple if the MATLAB extension ("MEX-Files") is used which comes with the software. We recommend to set a permanent path in MATLAB to the following directory (english/german windows):

```
c:/Program Files/Adaptif Photonics GmbH/
Polarization Navigator/Bin/Matlab/
```

or

```
c:/Programme/Adaptif Photonics GmbH/
Polarization Navigator/Bin/Matlab/
```

After having done so, you can use the following new MATLAB commands:

Commands: `[response,result]=MEX_PolNav_SendCommand(target,command)`  
Send a command to the polarizationNAVIGATOR™ and receive a string response. **result** contains an error code.

`[response,result]=MEX_PolNav_SendCommandEx(target,command)`  
Send a command to the polarizationNAVIGATOR™ and receive plot data. **result** contains an error code.

Please type `help MEX_PolNav_SendCommand` or `help MEX_PolNav_SendCommandEx` at the MATLAB command prompt for details of the calling parameters.

Here is a simple example on how the component test application (see target *CompTest* (section 11.8) ) can be automated using MATLAB:

```
MEX_PolNav_SendCommand('CompTest*', 'Activate');
MEX_PolNav_SendCommand('CompTest*', 'Set WavelengthStart,1540');
MEX_PolNav_SendCommand('CompTest*', 'Set WavelengthStop,1550');
MEX_PolNav_SendCommand('CompTest*', 'SingleMeasurement');
while 1
```

```

[response,result]=MEX_PolNav_SendCommand('CompTest*',
    'Get Progress');
if str2num(response)==2;
    break;
end
pause(1);
end;
[PlotData,result]=MEX_PolNav_SendCommandEx('CompTest*',
    'GetPlot Default');
plot(PlotData(:,1),PlotData(:,2));

```

Make sure that the polarizationNAVIGATOR™ is already started before executing the MATLAB script. In the folder "DemoMATLAB", you can find the m-file PolNavPERTest.m which is an example for controlling the PER-measurement application.

### 11.13 Using LabView

As described in the chapter *DLL Interface* (section 11.2) , the DLL PolNavClient.dll can be used to communicate with the polarization NAVIGATOR. Making use of this DLL is very simple if the LabView-VIs are used which come with the polarization NAVIGATOR. The necessary VIs are located in the library file PolNavClient.llb.

There is only one VI named **SendCommand.vi** which communicates with the polarizationNAVIGATOR™.

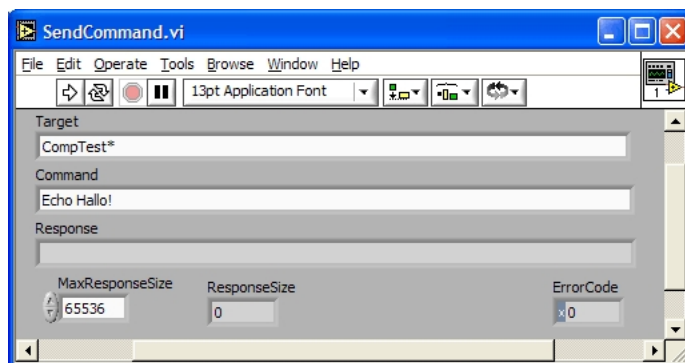
Input parameters:	Target, Command, MaxResponseSize
Output parameters:	Response, ResponseSize, ErrorCode

Input parameters are the communication target and the actual command. Refer to *Target Names* (section 11.3) for details on the available commands. Refer to *Error Codes* (section 15.3) for details on the possible error results.

Note that the polarizationNAVIGATOR™ has to be started prior to sending these commands.

You can also find some example VIs in the library PolNavClient.llb:

- PolNavClient\_ComponentTest\_Demo.vi gives an example implementation for automating the component test application (Target: *CompTest* (section 11.8) ).
- PolNavClient\_PER\_Demo.vi gives an example implementation for automating the PER application (Target: *PERTest* (section 11.10) ).



## 11.14 Using Python

As described in the chapter *DLL Interface* (section 11.2) the DLL `PolNavClient.dll` can be used to communicate with the polarization NAVIGATOR. Making use of this DLL is very simple if the Python-extension is used which comes with the polarization NAVIGATOR. We recommend to copy the DLL `PyPolNav.dll` into your Python DLL-directory (typically named `c:/Program Files/PythonXX/DLLs/`). You can find this DLL in the directory `DemoPython2.2` or `DemoPython2.4` depending on the Python version you are using.

After having done so, you can use the extension by importing the DLL using the following command:

```
import PyPolNav
```

Check the availability of the DLL as follows (returns the version number):

```
print "PyPolNav.dll version:" print PyPolNav.GetDLLVersion()
```

A simple communication with the polarizationNAVIGATOR™ could be as follows:

```
print "polarization NAVIGATOR version:" print  
PyPolNav.SendCommand("Global","Get Version")
```

The last error code can be read as follows:

```
ErrorCode=PyPolNav.LastError()
```

Note that the polarizationNAVIGATOR™ has to be started prior to sending these commands. Refer to *Target Names* (section 11.3) for details on the available commands. Refer to *Error Codes* (section 15.3) for details on the possible error results.

You can also find a simple demo script `PERTest.py` located in the folder `DemoPython2.2` or `DemoPython2.4` showing how to use the PER application with Python.

## 11.15 Using VBA

As described in the chapter *DLL Interface* (section 11.2) the DLL `PolNavClient.dll` can be used to communicate with the polarization NAVIGATOR. You can directly access the DLL functions from *Microsoft Visual Basic for Applications* (VBA), e.g. from EXCEL.

The corresponding declarations are:

```
Declare Function PolNav_SendCommand& Lib "PolNavClient.dll" _  
    Alias "?PolNav_SendCommand@@YGHPBDOPADHAAH@Z" _  
    (ByVal Target As String, ByVal Command As String, _  
    ByVal Response As String, ByVal MaxLen As Long, _  
    ByRef ResponseLen As Long)  
  
Declare Function PolNav_ReadResponse& Lib "PolNavClient.dll" _  
    Alias "?PolNav_ReadResponse@@YGHHHPADHAAH@Z" _  
    (ByVal iStart As Long, ByVal iLength As Long, _  
    ByVal Response As String, ByVal MaxLen As Long, _  
    ByRef ResponseLen As Long)
```

See *DLL Interface* (section 11.2) for details on the parameters. An example using Microsoft EXCEL is included in the software package. The filename is `PolNavClientDemo1.xls` located in the directory `c:/Program Files/Adaptif Photonics GmbH/Polarization Navigator/Examples/`

## 12 File Types

### 12.1 PBIN-Files

The default file format used by the polarizationNAVIGATOR™ is a binary file format with the extension ".pbin". These files contain measurement data such as SOP measurements or PMD measurements. For MATLAB integration, m-files are provided to load PBIN-files (see chapter *MATLAB File Handling* (section 12.7) ).

### 12.2 Measurement Series

The polarizationNAVIGATOR™ supports handling of measurement series. You can load a series of measurements (e.g. a collection of long term data) into a single document. Use the *File→Import Series* to import all PBIN-files contained in a single directory. Use *File→Save As* to save the complete series into a single PBIN-file.

Once the series is loaded into a single document, you can export the data as *CSV-file* (section 12.3) or *MAT-file* (section 12.7.1) .

### 12.3 CSV-Files (Comma Separated Values)

If you want to export data in CSV format use the menu entry *File→Export*. Please choose a target filename with the extension ".csv". After selecting the target filename a dialog box may appear allowing you to choose which data will be exported into that file. See the *ASCII File Formats* (section 15.4) for details on the data organization.

The generated files can be imported e.g. to EXCEL. Please note that the polarizationNAVIGATOR™ uses the localized decimal point. For English systems, this is usually ".", the value separator is "," accordingly. For German systems, the decimal point is "," and the value separator is ";". You can change these settings in the Windows control panel.

#### 12.3.1 Measurement Series

For measurement series, data of one type is formatted to form a block. Thus, for example, all DOP values belonging to different measurements are grouped together to simplify generation of 3-dimensional plots.

Note that only series can be exported containing measurements with the same number of data points each.

### 12.4 ASCII-Files

If you want to export data in ASCII format use the menu entry *File→Export*. Please choose a target filename with the extension ".asc". After selecting the target filename a dialog box may appear allowing you to choose which data will be exported into that file. See the *ASCII File Formats* (section 15.4) for details on the data organization.



## 12.5 PMR-Files

Files with the extension ".pmr" are created by the PMD field tester module N3909A belonging to the Agilent Modular Network Tester (MNT) platform. These files can be imported into the polarizationNAVIGATOR™ to be viewed. Furthermore, they can be exported as PDF reports (see chapter *Report Generation* (section 13) ).

## 12.6 CD-Files

Files with the extension ".cd" are created by the 4-wavelength OTDR module N3916AL belonging to the Agilent Modular Network Tester (MNT) platform. These files can be imported into the polarizationNAVIGATOR™ to be viewed. Furthermore, they can be exported as PDF reports (see chapter *Report Generation* (section 13) ).

## 12.7 MATLAB File Handling

### 12.7.1 Exporting MATLAB Files

If you want to export data as MATLAB .mat-files use the menu entry **File→Export**. Please choose a target filename with the extension ".mat". Note that you need MATLAB to use this feature.

If you load the .mat-file into the MATLAB workspace the variable "Data" contains the exported information as a struct variable. Type in "Data" to see the contents:

```
Data Data =  
    Lambda: [2077x1 double]  
      DGD: [2077x1 double]  
      PDL: [2077x1 double]  
    Power: [2077x1 double]  
PDLDivided: [2077x2 double]  
  PDLPSP: [2077x3 double]  
    PSP: [2077x3 double]  
  PMD2nd: [2077x1 double]  
    Info: [1x1 struct]  
  Mueller: [2077x16 double]  
    Jones: [2077x4 double]
```

See also *PDL/PMD Application* (section 6.2) .

### 12.7.2 Loading PBIN-Files into MATLAB

You can load PBIN-files into the MATLAB workspace using the following command:

```
Data=PBinRead('Filename.pbin');
```

Note that you have to set a path into the directory containing the .m-files. This is typically

```
C:\Program Files\Adaptif Photonics GmbH\Polarization  
Navigator\Bin\Matlab\
```

## 13 Report Generation

### 13.1 Generating PDF Reports

The documents containing the measurements can be exported as a PDF file. This includes graphical data (e.g. DGD curves) as well as scalar results such as the PMD value. The report generator can process multiple files in a single run. For example, all .pbin-files contained in a directory can be converted into multiple PDFs or they can be written into a single PDF.

The appearance of these reports can be highly customized. For example, a company logo can be placed on the page(s) or the information can be reduced to only the relevant data of a specific customer. Also specific parameters can be interactively queried from the customer in a customizable dialog (e.g. DUT name or serial number).

The layout is defined by a definition file, the so-called *report template*. This file uses the XML syntax and can be seen as a simple script language. The command reference is given in the next chapters.

#### 13.1.1 Creating a Report for the Current Document

You can generate a single report from the current document using the following steps:

- Open your document.
- Click on *Tools*→*Report Generator* or on the PDF-icon in the toolbar.
- The report generator wizard appears. Select "Current document" from the list.
- Select a report template from the list (apparently only one template is selectable).
- Click on "Next".
- Enter additional information if desired in the next page.
- Click on "Next".
- Click on "Finish".
- You will be asked for a target filename.

Now, a PDF file is generated and opened afterwards.

NOTE: A PDF viewer such as the *Acrobat Reader* needs to be installed on your system.

#### 13.1.2 Creating a Report for all Gallery Documents

You can generate multiple reports from all opened documents in the gallery using the following steps:

- Open several documents.
- Only documents of the same class can be processed at once (e.g. either only SOP measurements or PMD measurements). Bring a typical document you want to process to the front.

- Click on *Tools*→*Report Generator* or on the PDF-icon in the toolbar.
- The report generator wizard appears. Select "All gallery documents" from the list.
- Select a report template from the list (apparently only one template is selectable).
- Click on "Next".
- Choose if you want several PDF files to be generated or a single PDF file.
- Click on "Next".
- Choose the target directory.
- Click on "Next".
- Enter additional information if desired in the next page.
- Click on "Next".
- Click on "Finish".
- You will be asked for a target filename and if needed for a target directory.

### 13.1.3 Creating a Report for all Documents Contained in a Directory

You can generate multiple reports from all documents contained in a single directory using the following steps:

- Only documents of the same class can be processed at once (e.g. either only SOP measurements or PMD measurements). Bring a typical document you want to process to the front or close all documents.
- Click on *Tools*→*Report Generator* or on the PDF-icon in the toolbar.
- The report generator wizard appears. Select "All document contained in a folder" from the list.
- Select a report template from the list.
- Click on "Next".
- Choose if you want several PDF files to be generated or a single PDF file.
- Click on "Next".
- Choose the target directory.
- Click on "Next".
- Enter additional information if desired in the next page.
- Click on "Next".
- Click on "Finish".
- You will be asked for a target filename and if needed for a target directory.

## 13.2 Report Templates

The report templates are located in the following directory (english/german windows):

```
c:/Program Files/Adaptif Photonics GmbH/  
Polarization Navigator/Bin/ReportTemplates/
```

or

```
c:/Programme/Adaptif Photonics GmbH/  
Polarization Navigator/Bin/ReportTemplates/
```

You can make a copy of one of the existing .xml-files and modify it according to your needs.

### 13.2.1 File structure

A typical template file has the following structure:

```
<?xml version="1.0" ?>  
<ReportTemplate>  
  <Info>  
    <Value Name="DocClasses">3</Value>  
    <Value Name="LongName">Adaptif PBIN Files, PMD-Measurement</Value>  
    <Value Name="Extension">pbin</Value>  
    <Value Name="CountPages">no</Value>  
  </Info>  
  <UserDialog>  
    <Input Name="DUT" Prompt="Device Under Test : " Default="" />  
  </UserDialog>  
  <PageTemplate>  
    {Common Page Layout}  
  </PageTemplate>  
  
  {Pages}  
  
</ReportTemplate>
```

The "Info" node tells the polarizationNAVIGATOR™ something about the template file (e.g. which documents can be used, which filename extensions can be used for the source files etc.).

The <UserDialog> node includes additional parameters queried from the customer during the report generation.

The <PageTemplate> node contains commands which are processed whenever a new page begins.

The report layout itself is placed after the "PageTemplate" section.

## 13.3 Command Reference: Main Nodes

### 13.3.1 <Info> Node

The <Info> node tells the polarizationNAVIGATOR™ something about the template file (e.g. which documents can be used, which filename extensions can be used for the source files etc.).

A typical <Info> node looks as follows:

```
<Info>  
  <Value Name="DocClasses">3</Value>  
  <Value Name="LongName">Adaptif PBIN Files, PMD-Measurement</Value>  
  <Value Name="Extension">pbin</Value>  
  <Value Name="CountPages">no</Value>  
</Info>
```

Items:

```
<Value Name="DocClasses">DocClass1;DocClass2...</Value>
```

Enter the document classes this report is valid for. Valid class numbers are:

DocClass	Document Type
1	.pbin-files (SOP-Measurement)
2	.pbin-files (PMD-Measurement)
4	.pmr-files
5	.cd-files

```
<Value Name="LongName">Name</Value>
```

This entry defines the name displayed in the wizard dialog.

```
<Value Name="Extension">FilenameExtension1;FilenameExtension2...</Value>
```

This entry defines a list of applicable filename extensions (usually only "pbin").

```
<Value Name="CountPages">{no/yes}</Value>
```

The total number of pages might depend in certain cases on the measurement content. If you want the total number of pages to appear in the report, the report generator is called twice to count the pages. If "Count-Pages" is set to "no", this behavior is suppressed to speed up the process. If you know the number of report pages in advance, we recommend to set this value to "no".

### 13.3.2 <UserDialog> Node

The <UserDialog> node allows to configure a special page within the report generator wizard to query additional parameters from the user.

A typical <UserDialog> node looks as follows:

```
<UserDialog>
  <Input Name="DUT" Prompt="Device Under Test :" Default="" />
  <Input Name="ProductNumber" Prompt="Product Number :" Default="" />
  <Input Name="ProductSN" Prompt="Product S/N :" Default="" />
</UserDialog>
```

Items:

```
<Input Name="{VariableName}" Prompt="{UserPrompt}" Default="{DefaultValue}" />
```

Parameter	Description
VariableName	Identifier name for storing the user entry.
UserPrompt	String printed into the dialog box.
DefaultValue	Initial value of the input field. Will be pasted into the input field if the user clicks on "Reset to Defaults".

### 13.3.3 <PageTemplate> Node

The <PageTemplate> node contains commands which are processed at the beginning of every page. It can contain all commands listed in the following command reference.

A typical <PageTemplate> node looks as follows:

```
<PageTemplate>
  <Image x="0" y="0" Width="paper" Height="paper">Background.png</Image>
</PageTemplate>
```

This command places an image named "Background.png" located in the same directory as the template file on the top left corner of every page and scales it to the page width and page height.

## 13.4 Command Reference: Placing Text

### 13.4.1 `< t >< /t >`

Examples:

```
<t>Hello World</t>
<t Align="center">Hello World</t>
<t Linefeed="yes">Hello World</t>
```

Prints the text at the current cursor position.

Attribute	Description
Align	center: The text will be horizontally centered.
Linefeed	yes: A linefeed is performed at the end. no: No linefeed is performed at the end (default).

### 13.4.2 `< p >< /p >`

Examples:

```
<p>Hello World</p>
<p Align="center">Hello World</p>
<p Linefeed="no">Hello World</p>
```

Prints the text at the current cursor position and does a linefeed afterwards.

Attribute	Description
Align	center: The text will be horizontally centered.
Linefeed	yes: A linefeed is performed at the end (default). no: No linefeed is performed at the end.

### 13.4.3 `< Space/ >`

Example:

```
<t>Hello</t><Space/><t>World</t>
```

Prints a single space.

### 13.4.4 `< Font >< /Font >`

```
<Font Size="24"><t>Hello World</t></Font>
<Font Size="8" LineWidth="1.3"><p>abc</p><p>def</p></Font>
<Font Face="Helvetica"><t>Hello World</t></Font>
<Font Face="Helvetica-Bold"><t>Hello World</t></Font>
<Font Face="Symbol"><t>abg</t></Font>
```

Defines the appearance of the font

Attribute	Description
Size	Defines the font size. Default: 10
LineWidth	Defines the vertical space between the lines. Default: 1.0
Face	Defines the font to be used. Valid values are: Helvetica, Helvetica-Bold, Helvetica-Oblique, Helvetica-BoldOblique, Symbol, Courier, Courier-Bold, Courier-Oblique, Courier-BoldOblique, Times-Roman, Times-Bold, Times-Italic, Times-BoldItalic, ZapfDingbats. Default: Helvetica
Encoding	Defines the font encoding. Valid values are: WinAnsiEncoding, StandardEncoding, MacRomanEncoding, Symbol-Set, ZapfDingbats-Set. Default: WinAnsiEncoding

## 13.5 Command Reference: Text Layout

### 13.5.1 `< MoveTo/ >`

Examples:

```
<MoveTo x="30" y="14%" />
<MoveTo x="-170" />
<MoveTo dy="6" />
<MoveTo x="-34%" y="-4%" />
<MoveTo x="25%" />
<MoveTo y="48%" />
<MoveTo x="30" dy="24" Margin="left" />
```

Moves the virtual cursor to a position on the page.

Attribute	Description
x	x-Position in points or in percent of the page width. Negative value indicate positions relative to the right page border.
y	y-Position in points or in percent of the page height. Negative value indicate positions relative to the bottom page border.
dx	Relative x-Position in points or in percent of the page width.
dy	Relative y-Position in points or in percent of the page height.
Margin	Sets the text margin. <b>left:</b> Moves to the specified position and sets this position to be the left text box margin. <b>right:</b> Moves to the specified position and sets this position to be the right text box margin.

### 13.5.2 `< Box >< /Box >`

Examples:

```
<Box Style="frame"><p>Hello World</p></Box>
<Box Style="underline"><p>Hello World</p></Box>
<Box Color="gray" Width="40%"><p>Hello World</p></Box>
<Box Color="toggle" Width="40%"><p>Hello World</p></Box>
<Box Color="toggle" Width="40%" Style="underline"><p>Hello World</p></Box>
```

Puts the commands between the tags into a box. The box boundaries can be marked with lines. The box background can have different colors. The default width is given by the current x-position. In that case the right boundary is right page limit minus the current x-position. The vertical size is given by the current y-position when opening the box and the current y-position when closing the box.

Attribute	Description
x	x-Position in points or in percent of the page width. Negative value indicate positions relative to the right page border.
y	y-Position in points or in percent of the page height. Negative value indicate positions relative to the bottom page border.
Width	The desired width of the box, either absolute or in percent.
Height	The desired height of the box, either absolute or in percent.
Style	frame: Draws a frame around the box. overline: Draws a line on the top side of the box. underline: Draws a line on the bottom side of the box.
Color	gray: Sets the background color to gray. white: Sets the background color to white. toggle: Toggles between gray and white.
Border	Defines the border size between the frame and the text. A value of 1.0 corresponds to a character height.

### 13.5.3 < TabClear/ >, < TabSet/ >, < TabNext/ > ,

Examples:

```
<TabClear />
<MoveTo x="0%" />
<TabSet />
<MoveTo x="25%" />
<TabSet />
<MoveTo x="37%" />
<TabSet />
<t>Hello</t><TabNext/><p>World</p>
```

< TabClear/ > clears the tabulator list.

< TabSet/ > stores the current position in the tabulator list.

< TabNext/ > Moves the current position to the next tabulator position.

### 13.5.4 < HLine/ >

Examples:

```
<HLine/>
<p>Hello World</p>
<HLine/>
```

Draws a horizontal line at the current y position between the left and right text boundaries.

### 13.5.5 < PushPos/ >, < PopPos/ >

Examples:



```

<p>Hello</p>
<PushPos/>
<MoveTo x="-10%" y="-10%">
<DocParam Name="Today" />
<PopPos/>
<p>World</p>

```

< *PushPos* / > saves the current position on the position stack.

< *PopPos* / > recalls the current position from the position stack.

### 13.5.6 < *PageBreak* / >

Examples:

```

<PageBreak/>
<PageBreak Orientation="portrait" Paper="Letter" />

```

Begins a new page.

Attribute	Description
Orientation	tt portrait: Portrait format (default). tt landscape: Landscape format.
Paper	Defines the paper size. Valid values are: <b>a4</b> , <b>a3</b> , <b>a5</b> , <b>legal</b> , <b>letter</b> .

## 13.6 Command Reference: Placing Data from the Document

### 13.6.1 < *DocParam* / >

Examples:

```

<DocParam/>
<DocParam Name="PolNavVersion"/>
<DocParam Name="PolNavVersion" StopChar="," />
<DocParam Name="WavelengthStartDesired" Format="%.3f"/>
<DocParam Name="SweepRateMain" Format="%.0f"/>

```

Retrieves property values from the current document and writes them using the specified format onto the page.

Without any attributes, the command prints a list of available properties and their values. If you define a tab position using < *TabSet* / >, the values will be horizontally aligned.

Usually, a property name is specified using the **Name** attribute. See chapter *Document Property Names* (section 13.10) ) for a complete list of available properties.

Attribute	Description
Name	The name of the desired property.
Format	A C-style format string defining how the data will be formatted. An empty value indicates a string. %.3f Floating point value with 3 decimal digits. %.3g Floating point value with 3 significant decimal digits. Variable format. %d Integer value (signed). %u Integer value (unsigned).
StopChar	Defines a character which terminates the output. Only used with strings.

### 13.6.2 < DocParamLoadReg/ >, < PrintReg/ >

Example 1 (Print "highest" instead of 0):

```
<DocParamLoadReg Name="Resolution"/>
<Compare Operation="eq">0</Compare>
<If>
  <t>highest</t>
</If>
<Else>
  <DocParam Name="Resolution" Format="%.3f"/>
</Else>
```

Example 2 (Convert mW into dBm):

```
<DocParamLoadReg Name="Loss"/>
<Calc Operation="log10"/>
<Calc Operation="multiply">10</Calc>
<PrintReg Format="%.2f"/>
```

Simple computations can be performed using a global accumulator register.

< DocParamLoadReg/ > loads a document property value into this accumulator register. Further computations or conditional formats can be implemented in this way (e.g. a conversion from mW into dBm).

The property name is specified using the **Name** attribute. See chapter *Document Property Names* (section 13.10) ) for a complete list of available properties.

Attribute	Description
Name	The name of the desired property.

< PrintReg/ > prints the current content of the accumulator.

Attribute	Description
Format	A C-style format string defining how the data will be formatted. An empty value indicates a string. %.3f Floating point value with 3 decimal digits. %.3g Floating point value with 3 significant decimal digits. Variable format. %d Integer value (signed). %u Integer value (unsigned).

### 13.6.3 < PageNo/ >, < SetPageNo >< /SetPageNo >

Example:

```
<SetPageNo>1</SetPageNo>
<t>This is page</t><Space><PageNo/>
```

< SetPageNo > sets the page counter to the specified value.

< PageNo/ > prints the current page number.

### 13.6.4 < Filename/ >

Example:

```
<t>Source file:</t><Space><Filename/>
```

Prints the current source file name.

## 13.7 Command Reference: Placing Images/Plots

### 13.7.1 `< Image >< /Image >`

Examples:

```
<Image x="0" y="0" Width="paper" Height="paper">Background.png</Image>
<Image x="0" y="0" Width="320" Height="200">Logo.jpg</Image>
```

Places a JPG or PNG image onto the page.

Attribute	Description
x	x-Position in points or in percent of the page width. Negative value indicate positions relative to the right page border.
y	y-Position in points or in percent of the page height. Negative value indicate positions relative to the bottom page border.
Width	The desired width of the box, either absolute or in percent. A value of <b>paper</b> scales the width to the paper width.
Height	The desired height of the box, either absolute or in percent. A value of <b>paper</b> scales the height to the paper height.
Scaling	The picture can be scaled using the <b>Scaling</b> attribute. Default: 1.0

### 13.7.2 `< Plot >< /Plot >`

Examples:

```
<Plot Width="512" Height="384">DGD</Plot>
<Plot Width="512" Height="384" Scaling="0.5">TE/TM</Plot>
```

Places plot data onto the page. The name of the plot appears between the Tags. Valid values are:

#### **PMD measurements (.pbin-files)**

DGD, TE/TM, PDL, Power/Loss, SOPMD, Depol, PCD.

#### **SOP measurements (.pbin-files)**

Poincare, Stokes (norm), DOP, Stokes, Power.

#### **PMD measurements (.pmr-files)**

DGD, MaxDGD, SOPMD2nd Order PMD, PCD, Depol., DOP, Loss.

#### **CD measurements (.cd-files)**

absolute D, relative D, RGD, Slope, D/Slope.

Attribute	Description
x	x-Position in points or in percent of the page width. Negative value indicate positions relative to the right page border.
y	y-Position in points or in percent of the page height. Negative value indicate positions relative to the bottom page border.
Width	The desired width of the box, either absolute or in percent. A value of <b>paper</b> scales the width to the paper width.
Height	The desired height of the box, either absolute or in percent. A value of <b>paper</b> scales the height to the paper height.
Scaling	The picture can be scaled using the <b>Scaling</b> attribute. Default: 1.0

## 13.8 Command Reference: Placing Measurement Table Data

### 13.8.1 `< DocPlot/ >`, `< IsLastRow/ >`, `< NextDocRow/ >`, `< ResetDocRow/ >`

Examples:

```

<ResetDocRow />
<IsLastRow />
<Not />
<While>
  <DocPlot Name="Wavelength" Format="%.2f" />
  <NextDocRow />
  <IsLastRow />
  <Not />
</While>

```

The measurement plot data can be accessed using a row counter. The initial value of the row counter is 0.

`< ResetDocRow/ >` resets the row counter.

`< NextDocRow/ >` increments the row counter.

`< IsLastRow/ >` checks if the row counter is beyond the last entry and sets the global accumulator register to TRUE (1) or FALSE (0) accordingly.

`< DocPlot/ >` retrieves one data point and prints it as text into the document. The data point is identified by the plot name and the current row counter position. Valid plot names are:

#### **PMD measurements (.pbin-files)**

DGD, TE/TM, PDL, Power/Loss, SOPMD, Depol, PCD.

#### **SOP measurements (.pbin-files)**

Poincare, Stokes (norm), DOP, Stokes, Power.

#### **PMD measurements (.pmr-files)**

DGD, MaxDGD, 2nd Order PMD, PCD, Depol., DOP, Loss, Wavelength.

#### **CD measurements (.cd-files)**

absolute D, relative D, RGD, Slope, D/Slope, Wavelength, Frequency, No., Pass/Fail.

The attributes for the `< DocPlot/ >` command are:

Attribute	Description
Name	The name of the plot data.
Format	A C-style format string defining how the data will be formatted. An empty value indicates a string. %.3f Floating point value with 3 decimal digits. %.3g Floating point value with 3 significant decimal digits. Variable format. %d Integer value (signed). %u Integer value (unsigned).

### 13.8.2 < DocPlotLoadReg/ >

Example:

```
<DocPlotLoadReg Name="Pass/Fail" />
<If>
  <t>passed</t>
</If>
<Else>
  <t>failed</t>
</Else>
```

Loads the data point identified by the plot name and the current row counter position into the global accumulator register. Further evaluation or conditional commands can be processed afterwards.

Attribute	Description
Name	The name of the plot data. See chapter "Plot" (section 13.8.1) for a list of valid plot names.

```
<NextDocRow/>
```

## 13.9 Command Reference: Conditional Structures

### 13.9.1 < If >< /If >, < Else >< /Else >

Example:

```
<IsEmpty Name="Location A" />
<Not />
<If>
  <t>Location A</t>
  <TabNext />
  <DocParam Name="Location A" />
  <p></p>
</If>
<Else>
  <p>No location defined.</p>
</Else>
```

The < If > command executes the commands placed between its tags if the content of the global accumulator register is non-zero (TRUE). The < Else > command immediately following the if clause will be executed if the global accumulator contained a zero value (FALSE).

### 13.9.2 < While >< /While >

Example 1:

```
<TabClear />
<MoveTo x="0" />
<TabSet />
<LoadReg>1</LoadReg>
<While MaxIterations="20">
```

```

        <MoveTo dx="60" />
        <TabSet />
        <LoadReg>1</LoadReg>
    </While>

```

Example 2:

```

    <ResetDocRow />
    <IsLastRow />
    <Not />
    <While>
        <DocPlot Name="Wavelength" Format="%.2f" />
        <NextDocRow />
        <IsLastRow />
        <Not />
    </While>

```

The while command allows to create simple loops. The while command decides according to the state of the global accumulator register whether the statement is to be executed or not. In this example, the accumulator is loaded with 1 (TRUE) causing the loop to be started. Note that at the end of the loop, the condition has to be updated manually. You can limit the number of iterations using the **MaxIterations** attribute.

Attribute	Description
MaxIterations	The maximum number of iterations of the loop.

### 13.9.3 < LoadReg >< /LoadReg >

Example:

```

    <LoadReg>1.0</LoadReg>
    <While MaxIterations="20">
        <MoveTo dx="60" />
        <TabSet />
    </While>

```

Loads the global accumulator register with a constant.

### 13.9.4 < IsEmpty/ >

Example:

```

    <IsEmpty Name="Location A" />

```

Checks if the document property value described by the **Name** attribute is empty (TRUE) or not (FALSE). The result is stored in the global accumulator register.

Attribute	Description
Name	Document property name. See chapter <i>Document Property Names</i> (section 13.10) ) for a complete list of available properties.

### 13.9.5 < Not/ >

Example:

```

    <IsEmpty Name="Location A" />
    <Not/>
    <If>
        <p>Variable contains something</p>
    </If>

```

Inverts the logical state of the global accumulator register, i.e. turns TRUE (1) into FALSE (0) or vice versa.

### 13.9.6 < IsLastRow / >

```
<ResetDocRow />
<IsLastRow />
<Not />
<While>
  <DocPlot Name="Wavelength" Format="%.2f" />
  <NextDocRow />
  <IsLastRow />
  <Not />
</While>
```

Checks if the current row counter is beyond the last measurement row. The result is stored in the global accumulator register.

### 13.9.7 < Compare / >

Example:

```
<DocParamLoadReg Name="Resolution"/>
<Compare Operation="eq">0</Compare>
<If>
  <t>highest</t>
</If>
<Else>
  <DocParam Name="Resolution" Format="%.3f"/>
</Else>
```

Compares the current content of the global accumulator register with the value between the tags. Different compare operations can be selected by means of the **Operation**-tag. The result is stored in the global accumulator register.

Attribute	Description
Operation	Defines the compare operation. eq : equals ne : not equal le : less or equal lt : less than ge : greater or equal gt : greater than

### 13.9.8 < Calc / >

Example:

```
<DocParamLoadReg Name="Loss"/>
<Calc Operation="log10"/>
<Calc Operation="multiply">10</Calc>
<PrintReg Format="%.2f"/>
```

Allows to apply simple calculations on the global accumulator register. The **Operation**-tag defines which calculation is to be performed.

Attribute	Description
Operation	<p>Defines the operation.</p> <p><b>multiply</b> : multiplies the accumulator with the value between the tags.</p> <p><b>divide</b> : divides the accumulator by the value between the tags.</p> <p><b>add</b> : adds the value between the tags to the accumulator.</p> <p><b>sub</b> : subtracts the value between the tags from the accumulator.</p> <p><b>log</b> : calculates the natural logarithm from the accumulator.</p> <p><b>log10</b> : calculates the logarithm to the basis 10 from the accumulator.</p> <p><b>pow</b> : let V be the value between the tags, then <math>V^{Accumulator}</math> will be calculated.</p>

### 13.10 Command Reference: Document Property Values

#### Predefined Properties:

Property Name	Description
Today	The current time/date.
DestFilename	The name of the destination file.
SourceFilename	The name of the source file.
TotalPages	The total number of pages. Only valid if the CountPages entry in the Info block is set to "yes". Refer to chapter <i>Info node</i> (section 13.3.1) for details.

#### PMD Measurement (.pbin-files):

Property Name	Description
Date	The date/time the measurement was taken.
SNPolarimeter	Serial number of the polarimeter.
PolNavVersion	Version of the Polarization Navigator.
WavelengthStartDesired	Start wavelength in nm.
WavelengthStopDesired	Stop wavelength in nm.
SweepRateMain	Sweep rate in nm/s.
Resolution	Resolution in nm.
AutoResolution	Resolution mode: 1=auto, 0>manual.
UseLambdaLogging	Lambda-Logging mode: 1=on, 0=off.
PMD	PMD Value in ps.
AvrgPDL	Average PDL in dB.
Loss	Average transmission coefficient. Either in linear scale or in mW depending on the measurement mode.

#### SOP Measurement (.pbin-files):



Property Name	Description
Date	The date/time the measurement was taken.
SNPolarimeter	Serial number of the polarimeter.
PolNavVersion	Version of the Polarization Navigator.
SamplingRate	Sampling rate in kHz.
Wavelength	Start wavelength in nm.
SweepRate	Sweep rate in nm/s.
PeakPower	Peak power in mW.

### PMD Measurement (.pmr-files):

Property Name	Description
Date/Time	The date/time of taking the measurement.
Cable ID	The cable ID.
Fiber ID	The fiber ID.
Network Element	The name of the network element.
Problem ID	The problem ID.
Operator Name	The operator name.
Mainframe ID	The product name of the mainframe.
Mainframe SN	The serial number of the mainframe.
Mainframe Rev	The revision number of the mainframe firmware.
Module ID	The product name of the measurement module.
Module SN	The serial number of the module.
Module Rev	The revision number of the module firmware.
Tx ID	The product name of the transmitter unit.
Tx SN	The serial number of the transmitter unit.
Tx Rev	The revision number of the transmitter firmware.
Tx Start Position [nm]	The start wavelength configured at the transmitter.
Tx Stop Position [nm]	The stop wavelength configured at the transmitter.
Tx Start Position [THz]	The start frequency in THz configured at the transmitter.
Tx Stop Position [THz]	The stop frequency in THz configured at the transmitter.
Tx Output Power [dBm]	The output power in dBm configured at the transmitter.

Property Name	Description
Start Position [nm]	The start wavelength configured at the receiver.
Stop Position [nm]	The stop wavelength configured at the receiver.
Measurement Mode	The measurement mode. E.g. "Single Sweep", "Continuous", "Averaging - Unlimited number of sweeps", "Averaging - Number of Sweeps x".
MaxHold Mode	The state of the max-hold mode. E.g. "On" or "Off".
Fiber Length [km]	The fiber length.
PMD Value [ps]	The PMD value.
Peak DGD [ps]	The peak DGD value.
Peak DGD (MaxHold) [ps]	The peak DGD value of the max-hold trace.
PMD Coeff. [ps/sqrt(km)]	The PMD coefficient.
SOPMD (avg) [ps <sup>2</sup> ]	The average second-order PMD.
PCD (avg) [ps/nm]	The average polarization dependent chromatic dispersion.
Depol.Rate (avg) [ps <sup>2</sup> ]	The average depolarization rate.
DOP (avg) [%]	The average degree of polarization.
Loss (avg) [dB]	The average loss.
Loss (max) [dB]	The maximum loss.

#### CD Measurement (.cd-files):

Property Name	Description
Instr. Type	The instrument product name.
Instr. SerialNo	The instrument serial number.
Instr. FW-Rev	The revision number of the instrument firmware.
Module Type	The product name of the module.
Module SerialNo	The serial number of the module.
Module FW-Rev	the revision number of the module firmware.
Module Calibrated	The last calibration date of the module.
AbsDispMin [ps/nm]	Minimum absolute dispersion.
AbsDispMax [ps/nm]	Maximum absolute dispersion.
RelDispMin [ps/(nm*km)]	Minimum relative dispersion.
RelDispMax [ps/(nm*km)]	Maximum relative dispersion.

Property Name	Description
Timestamp	The date/time the measurement was taken.
FiberLength	Values: "auto" or "manual".
Mode	
FiberLength [m]	The fiber length.
FiberType	The fiber type. Values: "SSMF (G.652)", "DSF (G.653)", "NZDSF (G.655)", "NegDSF (G.655)", "Unknown", "Mixed".
CurveFit	Values: "3 term Sellmeier", "4 term Sellmeier".
R2	The $R^2$ value.
Lambda0 [nm]	The Lambda0 value.
S0 [ps/(nm <sup>2</sup> *km)]	The S0 value.
D1550 [ps/(nm*km)]	The D1550 value.
Comment	Space for comments.
Label0	
Comment	Space for comments.
Label1	
Comment	Space for comments.
Label2	
Comment	Space for comments.
Label3	
Comment	Space for comments.
Label4	

## 14 Specifications

### 14.1 Specifications A1000

Operating Wavelength Range	1260 nm .. 1640 nm
Factory Calibration Wavelength Range	A1000-B: 1270-1375 nm A1000-C: 1460-1620 nm
SOP Accuracy	$< \pm 1^\circ$ on Poincaré sphere
DOP Accuracy	$< \pm 2\%$ $< \pm 0.5\%$ (typ.) (after user calibration <sup>1</sup> )
Input Power Range	-50 dBm .. 7 dBm
Sampling Rate	up to 1 MHz
Maximum SOP Movement Rate <sup>2</sup>	$> 50$ kSOP-revolutions/s
Optical Connector	FC/PC or FC/APC
Operating Temperature	$+5^\circ\text{C} \dots +40^\circ\text{C}$
Interface	GPIB, USB
Analog Output	0 V .. 5 V
Power	100 V - 240 V, $< 30$ W

<sup>1</sup> Valid at calibration wavelength and calibration temperature

<sup>2</sup> SOP-revolutions in Stokes representation (Poincaré sphere) at -20 dBm

## 14.2 Specifications A2000

Operating Wavelength Range	1260 nm .. 1640 nm
Factory Calibration Wavelength Range	A2000-B: 1270-1375 nm A2000-C: 1460-1620 nm <sup>1</sup>
Wavelength Resolution	1 pm
Wavelength Accuracy <sup>2</sup>	15 pm
PMD <sup>3</sup> Range	0 .. 1000 ps
PMD Accuracy	$\pm(30 \text{ fs} + 2\% \text{ of PMD value})$
PDL Range	0 .. 10 dB
SOP Accuracy	$< \pm 1^\circ$ on Poincaré sphere (approx. 1.5% of s-parameter)
DOP Accuracy	$< \pm 2\%$ $< \pm 0.5\%$ (typ.) (after user calibration <sup>4</sup> )
Input Power Range	-50 dBm .. 7 dBm
Dynamic Range	$> 57 \text{ dB}$
Sampling Rate	up to 1 MHz
Maximum SOP Movement Rate <sup>5</sup>	$> 50 \text{ kSOP-revolutions/s}$
Optical Connector	FC/PC or FC/APC
Operating Temperature	$+5^\circ\text{C} \dots +40^\circ\text{C}$
Interface	GPIO, USB
Analog Output	0 V .. 5 V
Power	100 V - 240 V, $< 30 \text{ W}$

<sup>1</sup> The wavelength range for passive component test applications is determined by the overlap between the wavelength range of the tuneable laser and the wavelength range of the selected A2000 instrument.

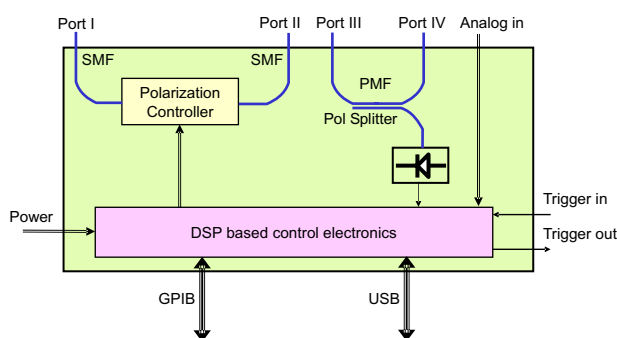
<sup>2</sup> Valid for operation with Agilent family of tuneable lasers. Because wavelength accuracy is determined by the tuneable laser, operation with other lasers may result in different wavelength accuracy.

<sup>3</sup> Average DGD value across 100nm wavelength range

<sup>4</sup> Valid at calibration wavelength and calibration temperature

<sup>5</sup> SOP-revolutions in Stokes representation (Poincaré sphere) at -20 dBm

### 14.3 Specifications A3000



Wavelength	1260 nm .. 1640 nm (scrambling and switching) 1550 nm $\pm$ 30 nm (stabilization <sup>1</sup> )
SOP Switching Time	< 10 $\mu$ s
Scrambler Speed	up to 100 kSOPs/s
Reset-free operation	yes
DOP	< 5% (scrambling)
Polarization Extinction Ratio	> 25 dB (stabilization)
Insertion Loss	< 3 dB (scrambling and switching) < 5 dB (stabilization)
Max Input Power (Port I,II)	20 dBm
Max Input Power (Port III)	0 dBm
Trigger Input	TTL
Analog Input	0 .. 10 V
Optical Connector	FC/PC or FC/APC
Operating Temperature	+5°C .. +40°C
Interface	GPIB, USB
Analog Output	0 V .. 5 V
Power	100 V - 240 V, < 30 W

<sup>1</sup> Using the optical feedback signal through ports III and IV

### 14.4 Specifications A3200

Wavelength	1260 nm .. 1640 nm
SOP Switching Time	< 10 $\mu$ s
Scrambler Speed	up to 100 kSOPs/s
Reset-free operation	yes
DOP	< 5% (scrambling)
Insertion Loss	< 3 dB
Max Input Power	20 dBm
Trigger Input	TTL
Optical Connector	FC/PC or FC/APC
Operating Temperature	+5°C .. +40°C
Interface	GPIB, USB
Analog Output	0 V .. 5 V
Power	100 V - 240 V, < 30 W

## 14.5 Specifications A3300

Wavelength <sup>1</sup>	1260 nm .. 1640 nm
SOP Switching Time	< 10 $\mu s$ (non-deterministic) < 25 $\mu s$ (deterministic)
Scrambler Speed	up to 100 kSOPs/s
Reset-free operation	yes
DOP	< 5% (scrambling)
Remaining SOP error	< 2° (stabilizing)
Polarimeter Operating Wavelength	1260 nm .. 1640 nm
Polarimeter Factory Calibration Wavelength <sup>2</sup>	A3300-B: 1270-1375 nm A3300-C: 1460-1620 nm
SOP Accuracy <sup>3</sup>	< $\pm 1^\circ$ on Poincaré sphere
DOP Accuracy	< $\pm 2\%$ < $\pm 0.5\%$ (typ.) (after user calibration)
Insertion Loss	< 4 dB
Input Power Range <sup>4</sup>	-26 dBm .. 19 dBm
Sampling Rate	up to 1 MHz
Trigger Input	TTL
Optical Connector	FC/PC or FC/APC
Operating Temperature	+5°C .. +40°C
Interface	GPIO, USB
Analog Output	0 V .. 5 V
Power	100 V - 240 V, < 30 W

<sup>1</sup> In "Deterministic Stokes" application: full accuracy is achieved only in factory calibration range of the polarimeter

<sup>2</sup> Other wavelength ranges on request

<sup>3</sup> With respect to the signal at the output connector of the instrument

<sup>4</sup> Other input power ranges on request

## 15 Reference

### 15.1 Command Line Parameters

The following command line parameters are supported by the software:

Command Line Switch	Description
/minimize	The software will be minimized to the system tray on startup. This may be useful if the polarizationNAVIGATOR™ is only needed for remote control or as automation target.

### 15.2 Polarimeter Input Ranges

The following table shows the permitted input power ranges for all available gain settings. If the input power falls below the lower boundary measurement results become noisy due to quantization. If the input power exceeds the upper boundary, errors may appear due to limits of the input amplifier. You can manually choose a specific gain setting by disabling the auto-gain function (i.e.  $TreeNo=3/VarNo=14$  (section 10.2)  $AutoGainFlag = 0$ ).

Gain	Max. Input Power	Power Range
0	7 dBm	0dBm .. 7dBm
1	4 dBm	-3dBm .. 4dBm
2	0 dBm	-7dBm .. 0dBm
3	-3 dBm	-10dBm .. -3dBm
4	-6 dBm	-13dBm .. -6dBm
5	-10 dBm	-17dBm .. -10dBm
6	-13 dBm	-20dBm .. -13dBm
7	-16 dBm	-23dBm .. -16dBm
8	-20 dBm	-27dBm .. -20dBm
9	-23 dBm	-30dBm .. -23dBm
10	-26 dBm	-33dBm .. -26dBm
11	-30 dBm	-37dBm .. -30dBm
12	-33 dBm	-40dBm .. -33dBm
13	-36 dBm	-43dBm .. -36dBm



## 15.3 Error Codes

The following table lists all available error codes and its explanation:

Error Code (HEX)	Description
0x0000	No error
0x0003	Undefined function
0x0007	Memory allocation error
0x0008	Memory overflow error
0x000B	Variable type mismatch
0x0011	Generic error
0x0035	Unknown tree number
0x0036	Unknown variable
0x0037	Variable access violation
0x0038	Unknown variable type
0x0039	Parameter missing/Wrong number of parameters
0x0054	Health check error
0x0063	Target not found
0x0064	Unknown command
0x0065	Response buffer overflow
0x0067	Referencing error
0x0068	Resolution error
0x0400	Polcontroller generic error
0x0401	Polcontroller memory allocation error
0x0601	Polarimeter no calibration data
0x0602	Polarimeter calibration range
0x0603	Polarimeter measurement timeout
0x0604	Polarimeter measurement in progress
0x0605	Polarimeter measurement sequence error
0x0609	Polarimeter measurement overrange
0x060A	Polarimeter measurement underrange

## 15.4 ASCII File Formats

### 15.4.1 SOP Data (Default)

Column 1:	Wavelength in nm
Column 2:	Time in s
Column 3:	DOP
Column 4:	$S_0$ in mW
Column 5:	$S_1$ in mW
Column 6:	$S_2$ in mW
Column 7:	$S_3$ in mW
Column 8:	Corresponding ADC Range (0..1)
Column 9:	$s_1$
Column 10:	$s_2$
Column 11:	$s_3$

### 15.4.2 PDL/PMD Data (Default)

---

Column 1:	Wavelength in nm
Column 2:	DGD in ps
Column 3:	PDL in dB
Column 4:	Power in mW or -Loss (linear scale)
Column 5:	TE (Power in one PDL axis)
Column 6:	TM (Power in other PDL axis)
Column 7:	$s_1$ of PDLPSP
Column 8:	$s_2$ of PDLPSP
Column 9:	$s_3$ of PDLPSP
Column 10:	$s_1$ of PSP
Column 11:	$s_2$ of PSP
Column 12:	$s_3$ of PSP
Column 13:	2nd-order PMD in ps <sup>2</sup>
Column 14:	PCD in ps <sup>2</sup>
Column 15:	Depolarization in ps <sup>2</sup>

---

### 15.4.3 Mueller Data

---

Column 1:	$M_{11}$
Column 2:	$M_{12}$
Column 3:	$M_{13}$
Column 4:	$M_{14}$
Column 5:	$M_{21}$
Column 6:	$M_{22}$
.	
.	
.	

---

### 15.4.4 Jones Data

---

Column 1:	$\text{Re}(J_{11})$
Column 2:	$\text{Re}(J_{12})$
Column 3:	$\text{Re}(J_{21})$
Column 4:	$\text{Re}(J_{22})$
Column 5:	$\text{Im}(J_{11})$
Column 6:	$\text{Im}(J_{12})$
Column 7:	$\text{Im}(J_{21})$
Column 8:	$\text{Im}(J_{22})$

---

### 15.4.5 Jones Data + Lambda

---

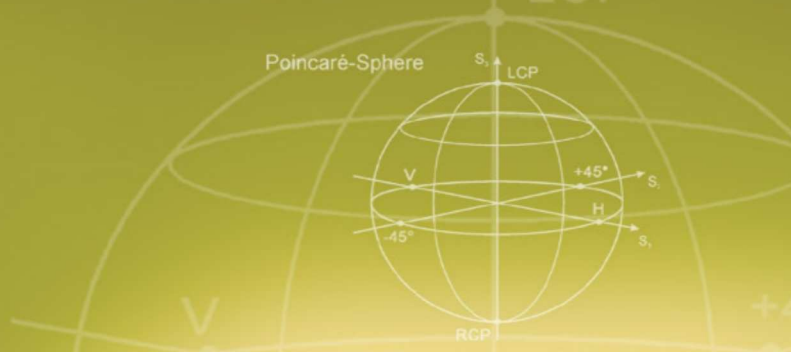
Column 1:	Wavelength in nm
Column 2:	$\text{Re}(J_{11})$
Column 3:	$\text{Re}(J_{12})$
Column 4:	$\text{Re}(J_{21})$
Column 5:	$\text{Re}(J_{22})$
Column 6:	$\text{Im}(J_{11})$
Column 7:	$\text{Im}(J_{12})$
Column 8:	$\text{Im}(J_{21})$
Column 9:	$\text{Im}(J_{22})$

---

#### 15.4.6 SOP Data

Column 1:	$S_0$ in mW
Column 2:	$S_1$ in mW
Column 3:	$S_2$ in mW
Column 4:	$S_3$ in mW





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